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1939, No. 3 September 9

Range and Homing of Individual Box Turtles

By J. T. Nichols

IN marking box turtles (*Terrapene carolina*) at Mastic, Long Island, over a period of about twenty years, probably the majority of individuals handled were brought to me to be marked or examined by my children and others. The locality where they were then liberated was recorded, and in some cases the approximate locality where they had been found. This approximate locality of capture was recorded pretty consistently as well in such turtles as I found personally, most of which were brought home to be marked or examined, though some were liberated where found. I thus find in my records which I have recently had extracted and compiled (see Copeia, 1939: 14), 163 locality references for sixty-two individual turtles which give evidence as to the individual range and homing instinct of this animal.

The point of liberation of the turtles is definite, but the points of capture are all approximate, and the distances between have been estimated in yards later, doubtless with varying accuracy, and probably with a conservative tendency to underestimates. This should be borne in mind with reference to the data presented, which, nevertheless, probably give a correct idea of the distances covered.

The house near which most of the turtles were liberated is in general a little less than a mile in a straight line, in directions from south-southwest to east through southeast, from the shore of the bay which curves irregularly. This quadrant, comprising some woodland and a large amount of more or less open lots separated by stands of trees, was most thoroughly covered. Most of the turtles were found here and such as moved off in this direction had the best chance of recapture. In the other directions, almost entirely woodland for some distance, fewer turtles were taken and there was less chance of their recapture.

I have definite locality record of only fourteen succeeding captures with time intervals of one month to six years of twelve turtles when these had not been moved. Their distances from previous captures vary from 50 yards, or less, to 250 yards (a little over ⅛ mile), average 130 yards. The time interval makes little difference, for whereas it was an interval of five years which gave 250 yards, one of only seventy-two days gave 200 yards, and one of six years 50 yards or less.

The normal diameter of a turtle's range is about ⅛ mile (220 yards), but they doubtless sometimes wander much farther or shift their ranges. A large male turtle was taken three times in 1924 in or near a swamp to which it was apparently resorting to recover from serious injuries. Though liberated only 50 yards from its last point of capture in 1924, in 1926 it was found 1050 yards (well over ½ mile) away.

Two turtles were brought from considerable distances, the first some 20 miles from across Long Island, the second some 4 miles from dunes across the bay. Neither attempted to return so far as known, the first being found 200 yards from its point of liberation two years later, the second 60 yards one year later.

The greatest diameter of area of captures of sixty other turtles, influenced no doubt by their removal to various distances for liberation, has been estimated. In forty-four (73⅓ per cent) it is 250 yards or less, in ten (16⅔ per cent) more than 250 and less than 500 yards, and in six (10 per cent) over 500 yards.

Of these sixty turtles, forty-five show evidence of homing instinct or tendency to return to a locality from which they had been removed, or evidence of lack of such instinct or tendency. Thirty-seven of the forty-five (82 per cent) are in the first group, eight (18 per cent) in the second. Among these latter is No. JN-18-13 which wandered off over half a mile, covering a much greater distance than any other turtle, except in returning from a point of liberation to home territory. Yet this individual had sufficient locality sense to find and return a short distance to a swamp when recovering from wounds. No. JN-21-26, a grown turtle, liberated 700 yards from its point of capture, went off 250 yards in an opposite direction. These are exceptional individuals. Four of the eight turtles which seemed to lack homing instinct were young; the instinct is probably less well developed in young than in grown turtles, though sometimes adequate.

A turtle doubtless sometimes shifts its home territory with the passage of years. Thus No. JN-16-18 taken with an interval of four years at localities only 125 yards apart, in two years moved on 375 yards (to 700 yards from where it had last been liberated). No. WF-84 taken with an interval of six years at localities 175 yards apart, in four years more moved off 300 yards (to 475 yards from where it had last been liberated). No. JN-20-23, removed 250 yards, was back next year to 50 yards or less from where first taken, and left there. When found five years later it had moved on another 250 yards.

Homing data on turtles moved upwards of ½ mile is free from some of the complications when they have been moved shorter distances. I have such data on only thirteen turtles, and this has been summarized in the following table. Eleven, four males, four females, and three undetermined, with plastron lengths varying from 5 to 5⅝ inches, returned distances varying from 1000 to 1400 yards. The elapsed time between their liberation and recapture, always so far as recorded on "home" territory, varied from less than three months to ten years. One individual was back in seven days and another in one day to territory where it was then and had previously been found, but unfortunately there is no record of the point of capture of either immediately prior to liberation. The presumption is that these turtles always returned to the same area, and when brought in without data were from there, but there is no proof. Three of them certainly returned to it twice, and one, on this basis, presumably did so five times. No. JN-22-13 was originally taken on the right side, had been liberated at the head, and apparently moved off (perhaps in an air line towards home) on the left side of a curving creek that farther down broadened and would have been crossed with difficulty. Hence one out of three of its recorded points of capture was across the broad lower part of the creek at an estimated distance of 500 yards.

The two remaining turtles of the thirteen, measuring respectively 4¼ and 4½ inches in plastron length, were each moved 1200 yards, and neither returned toward its point of capture. The first was found seven years later

200 yards from the point of liberation; the second was found a year later near its point of liberation, dying.

TURTLES MOVED UPWARDS OF ½ MILE (880 YARDS)

No. of turtle	Size when first moved (in inches)	Span years covered by captures	Greatest diameter area of captures	Greatest distance returned to area of captures	No. of times returned this or similar distance
4-16	5¼	3 mos.	50 yds.	1400 yds.	1
JN-16-13♂	5	9 yrs.	180 yds	1050 yds.	2
JN-17-4♂	5½	10 yrs.	100 yds. or less	1000 yds.	1
JN-18-22♂	5¼	7 yrs.	150 yds.	1050 yds.	1
JN-19-10♀	5⅜	8 yrs.	50 yds.	1100 yds.	2 or 3
JN-20-1♂	5⅜	1 yr.	75 yds.	1200 yds.	1
JN-20-2	4¼	7 yrs.	1200 yds.	no return	
JN-20-11♀	5⅝	4 yrs.	100 yds.	1100 yds.	1 or 2
JN-20-17	5⅜	3 yrs.	50 yds.	1000 yds.	1
JN-22-13	5¾	15 yrs.	500 yds.	1225 yds.	2 to 5
JN-23-47	4½	1 yr.	1200 yds.	no return	
JN-25-48♀	5⅛	1 yr.	300 yds.	1000 yds.	1 or 2
JN-29-32♀	5½	7 yrs.	50 yds.	1200 yds.	1

Data on only seven young turtles (with plastron lengths 4½ inches and less) is too scanty to be conclusive as to their homing propensities. In addition to the two moved 1200 yards (see above), one of 4¼ inches moved 700 yards did not return toward its point of capture; one of 3⅝ inches moved 175 yards, four years later had wandered off in another direction 300 yards.

On the other hand one of 3¾ inches, moved 700 yards, was found four years later (dead) 50 yards from its original locality—one of 3⅞ inches, moved 500 yards, was found thirteen years later (also dead) 100 yards from its home territory—and one of 4¼ inches, moved 300 yards, three years later was 50 yards from its original locality.

SUMMARY AND CONCLUSIONS

(1) The normal range of most of the turtles has a diameter of 250 yards or less.

(2) With the passage of years the range may be shifted somewhat.

(3) A very exceptional turtle may wander more than ½ mile (one instance).

(4) Most grown turtles (89.5 per cent) showed some homing instinct or tendency to return to territory from which they were moved. Exceptional individuals definitely did not.

(5) All grown turtles (eleven individuals), moved a distance from ½ to about ¾ mile, went back toward the locality in which they had been found; returning for distances of 1000 to 1400 yards (14 to 20 returns inclusive).

(6) Only three out of seven young turtles (with plastron 4½ inches long or less) showed any tendency when moved to return to home territory. These three did so, the greatest distance returned being 700 yards.

(7) Two grown turtles brought from considerable distances, to which return would have been impractical, remained near where liberated.

THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

Amphibians and Reptiles of Northeastern Kentucky[1]

By Wilfred A. Welter and Katherine Carr

THE eastern section of Kentucky is distinct as to flora and fauna from the remainder of the state because of its mountainous nature. Most of the hills are forested with beech, chestnut, oak, pitch and scrub pine, walnut, and sweet and black gum, much of this forest being second growth timber injured by frequent burning. There are a number of caves in the area, particularly in Carter County, where Carter and Cascade Caves are located.

Garman (1894) published a preliminary list of the vertebrate animals of Kentucky. For the entire state he listed fifteen amphibians and twenty-five reptiles. Funkhouser (1925) in his *Wild Life in Kentucky* listed forty reptiles. Dury and Williams (1933) list fifty-two amphibians and reptiles for the state. None of the various scattered records of Kentuckian amphibians and reptiles which have appeared in recent years deal with Rowan County. The apparent shortage of records for eastern Kentucky has stimulated the biological staff of the State Teachers College, Morehead, to make natural history surveys in the vicinity of Morehead, in Rowan County. The senior author has completed a study of the fishes of the Licking River drainage, and, in conjunction with D. E. Sollberger, a study of the mammals of the section. The present paper is the third in the series of studies of the vertebrates of northeastern Kentucky.

The specimens obtained during the present survey were deposited in the Biology Museum at the Morehead State Teachers College. A list of the species taken during the present survey follows:

Necturus maculosus maculosus (Rafinesque).—Common in the streams of the Licking River drainage.

Cryptobranchus alleganiensis (Daudin).—Very common in Triplett and Licking rivers. It is often caught by local fishermen on trot-lines, and is easily taken at night in the smaller streams by the use of a flashlight.

Triturus viridescens viridescens (Rafinesque).—Fairly common throughout the area; taken at Morehead and at Carter Caves.

Ambystoma maculatum (Shaw).—Taken from ponds near Morehead in late February when breeding begins. Common, but seldom seen during the summer.

Ambystoma opacum (Gravenhorst).—Several taken from beneath stones at Morehead. One was also obtained from Morgan County.

Ambystoma texanum (Matthes).—Taken under rocks in a moist, low lying meadow near Morehead, and also in a dry pasture. Not very common.

Plethodon cinereus (Green).—Very common in shady woodlands beneath decaying stumps and logs. Taken at various stations in Rowan and Carter counties.

Plethodon glutinosus (Green).—Very common in shady places. It is most frequently found beneath stones along creek banks. Many were obtained in Rowan and Carter counties.

Gyrinophilus porphyriticus duryi (Weller).—Taken at Carter Caves in X-Cave within a few miles of the type locality, and also along North Fork of Triplet Creek near Morehead.

Pseudotriton montanus montanus (Baird).—Very common in the vicinity of Morehead; numbers are brought in to the laboratory each year.

Pseudotriton ruber ruber (Sonnini).—Not as common as *P. montanus* but several were obtained under rocks near creek beds in the vicinity of Morehead.

Eurycea bislineata bislineata (Green).—Taken many times in both Rowan and Carter

[1] The writers wish to express their appreciation to Dr. A. H. Wright for assistance in the identification of several forms.

counties. Specimens have been taken in a minnow seine in several feet of water as well as beneath rocks and stones in rather dry creek beds.

Eurycea longicauda (Green).—Obtained from springs, from caves, and from beneath stones at various stations in Carter and Rowan counties. One was obtained from a well near Grayson.

Eurycea lucifuga Rafinesque.—A few were obtained in Rowan County while a number were taken from Carter Caves.

Desmognathus fuscus fuscus (Rafinesque).—Very common in rich woodlands, where it is found under stones along the small streams. It is very abundant in the Carter Caves region. In Rowan County, burning of hillsides has practically eliminated it in the vicinity of Morehead.

Desmognathus fuscus ochrophaeus (Cope).—A few were taken in the Carter Caves region of Carter County. Not as common as *D. fuscus fuscus*.

Desmognathus phoca (Matthes).—Rather rare over most of Rowan and Carter counties, but very common near Paragon where many were obtained. On the whole it is much less abundant than *D. fuscus*.

Bufo americanus americanus Holbrook.—Rather common; more often encountered in summer on the ridges than in the valleys.

Bufo fowleri Hinkley.—The commoner species of toad. Abundant in all the valleys, but seldom encountered on the hilltops.

Acris gryllus (Le Conte).—Taken only in Rowan County, where individuals were located by their songs. Breeding apparently begins about the first of June.

Pseudacris brachyphona (Cope).—A very common spring frog. Breeding begins as early as February 12, when the marshes ring with the songs of this species and of *Hyla crucifer*. It is as abundant as *H. crucifer* and is usually found with it.

Hyla crucifer Wied.—Very common throughout eastern Kentucky. It starts singing as early as February 10.

Hyla versicolor versicolor Le Conte.—Not as common as the other two hylas, but nevertheless abundant

Rana catesbeiana Shaw.—Rather common. Local residents have reduced the number in recent years through gigging. Parties obtain as many as 100 large frogs in a single night.

Rana clamitans Latreille.—A few have been taken near Morehead. Not common.

Rana palustris Le Conte.—Obtained from several marshy areas near Morehead. Not common.

Rana sphenocephala Cope.—The commonest member of the genus in this section of the state. Many have been taken throughout Rowan and Carter counties.

Rana sylvatica Le Conte.—Much searching has revealed three specimens of this frog, all from the virgin timber at Carter Caves.

Sceloporus undulatus (Latreille).—Extremely common throughout eastern Kentucky.

Leiolopisma unicolor (Harlan).—A single specimen was taken at the CCC Camp in Rowan County.

Eumeces fasciatus (Linnaeus).—Taken at various stations in Rowan, Carter, and Fleming counties. It is a common species but much less abundant than *S. undulatus*.

Carphophis amoena helenae (Kennicott).—Very abundant. Along the North Fork of Triplet large numbers were obtained beneath rocks. Among all *Carphophis* examined in eastern Kentucky no typical *amoena* were found.

Diadophis punctatus edwardsii (Merrem).—Taken at numerous points in Rowan County. Usually found beneath rocks.

Heterodon contortrix (Linnaeus).—A very abundant snake often mistaken for the copperhead. Melanistic individuals are taken nearly as often as spotted individuals. Eggs were laid in the laboratory on several occasions; the number averaged fifteen. Captive specimens readily eat amphibians, particularly *Bufo fowleri*.

Opheodrys aestivus (Linnaeus).—Common, but often unnoticed because of its protective color. Obtained most frequently in low ground from alders. A captive specimen deposited five eggs.

Coluber constrictor constrictor (Linnaeus).—A common species taken at various places in Rowan, Fleming, and Carter counties. Locally called blue racer.

Elaphe obsoleta obsoleta (Say).—One of the very common snakes. In many specimens the banding is more distinct than in typical *obsoleta* and the scale count resembles that of *confinis*. Dr. Wright identified several individuals as *obsoleta*, but one he considered as having tendencies toward *confinis*. It is the writers' opinion that many are intergrades between the two forms.

Lampropeltis elapsoides elapsoides (Holbrook).—A single specimen was taken 6 miles east of Morehead. It was uncovered while stones were being removed in road building.

Lampropeltis getulus nigra (Yarrow).—An abundant snake in Rowan and all adjoining counties.

Lampropeltis triangulum triangulum (Lacépède).—A few specimens have been obtained from Rowan and Carter counties. It is much less common than *L. getulus nigra*.

Natrix septemvittata (Say).—Uncommon in the mountainous part of the state. A single specimen was obtained on the edge of the bluegrass region in Fleming County.

Natrix sipedon sipedon (Linnaeus).—Abundant along all creeks and streams. A medium-sized specimen was observed carrying a twelve-inch *Cryptobranchus* in its mouth. All specimens examined could be referred to this subspecies.

Storeria occipito-maculata (Storer).—Several taken near Morehead in Rowan County, and one from Morgan County. Rather rare.

Virginia valeriae elegans Kennicott.—Three taken in the vicinity of Morehead, each beneath a rock. This appears to be the first published record for this species in Kentucky.

Thamnophis sirtalis sirtalis (Linnaeus).—Numerous specimens taken in Rowan, Fleming, and Carter counties. A captive female gave birth to thirty-five young.

Agkistrodon mokasen Beauvois.—Even though severely persecuted the copperhead is holding its own in this region. As many as a dozen were taken within a radius of 2 miles of Morehead during the summer of 1938. Apparently the establishment of the Cumberland National Forest is partially responsible for its increase, as there is more food and more protective cover in the forest.

Crotalus horridus (Linnaeus).—The rock cliffs in this area are well populated with rattlers. Many are brought to the laboratory each year. A crew of men building a road 6 miles from Morehead killed upwards of twenty individuals this summer. Like the copperhead this species seems to have increased during the last few years.

Sternotherus odoratus (Latreille).—Specimens obtained from Licking near Farmers and from Triplet near Morehead are the first eastern Kentucky records. Not common.

Chelydra serpentina (Linnaeus).—Common in Triplet and Licking. Frequently caught on trot-lines.

Terrapene carolina (Linnaeus).—The most abundant turtle in eastern Kentucky.

Graptemys geographica (Le Sueur).—Specimens obtained from Licking near Farmers and from Fleming near Sherburne constitute the first eastern Kentucky records.

Chrysemys picta marginata (Agassiz).—Abundant in Gearhart and Lewis ponds in Rowan County. A specimen from Licking near Farmers has a single mid-dorsal stripe like *dorsalis*.

Amyda mutica (Le Sueur).—Obtained from Triplet in Rowan County and from Fox in Fleming County.

Amyda spinifera (Le Sueur).—A single specimen was taken from Fox Creek in Fleming County. Both species of *Amyda* are rare in this section. Funkhouser records them only from the Ohio and Pond rivers.

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State Teachers College, Morehead, Kentucky.

A New Species of the Lizard Genus *Lepidophyma* from Mexico

By Edward H. Taylor

THE genus *Lepidophyma* A. Duméril contains two known species, *smithii* Bocourt (Tehuántepec and western Guatemala) and *flavimaculatum* A. Duméril, (type locality, province of Petén, Guatemala). A third species is described herein from the high plateau region in eastern Hidalgo, Mexico.

Lepidophyma ***sylvatica,*** sp. nov.

Type.—EHT–HMS No. 16259; 7 mi. north of Zacualtipan, Hidalgo, Aug. 10, 1938; E. H. Taylor, collector.

Paratypes.—Nos. 16260, 16261, topotypes; same date and collector.

Diagnosis.—Related to *Lepidophyma smithii,* but differing in the absence of vertical rows of enlarged trihedral tubercles, and the presence of enlarged paired spots at base of tail. Females with smooth, males with keeled, ventral scales. A skinfold from axilla to groin.

Description of Type.—Head not flattened; rostral plate barely visible above; anterior nasals meeting in the median line behind rostral; these followed by a large azygous (frontonasal) scale in contact laterally with nasals and anterior loreal; a pair of prefrontals separated by two small intercalated scales, the anterior of which is the smaller (this condition is very probably anomalous, as the two paratypes show the prefrontals meeting on the median line and lacking the intercalated scales); a pair of frontals (Boulenger) between and projecting slightly over the orbit; a pair of frontoparietals and an interparietal, the latter bearing the "pineal eye"; these followed by a large pair of parietal scales; three temporal scales border the posterior head scales; a small anterior temporal followed by a much larger temporal scale, which in turn is followed by another small scale.

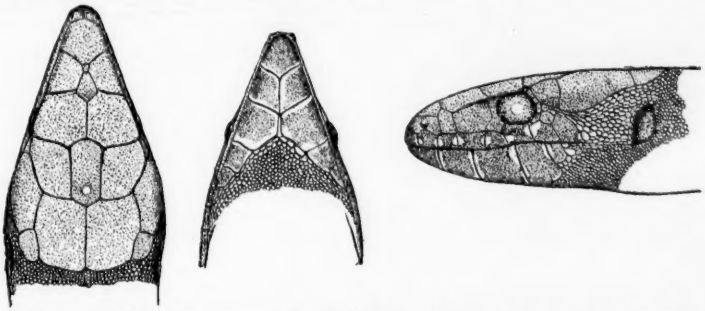

Fig. 1. Head of the type of *Lepidophyma sylvatica,* dorsal, ventral, and lateral views.

Nostril pierced between first labial and two nasals; the latter are partially fused together and at least on one side more or less fused to the first labial; anterior loreal higher than wide, higher than posterior part of nasal, touching two labials; posterior loreal about as wide as high, also touching two labials; two preocular scales partly fused on one side, the upper high and narrow, the

lower wider than high; a total of seven upper labials; four upper labials precede the subocular labial which is separated from orbit by a very narrow margin; four postocular scales well differentiated; palpebral edge covered by a long, very narrow scale which is not or only partially divided; a group of three or four small temporal scales immediately above labials; preauricular area covered with small scutes, larger than nuchal scutes, wedging in between posterior labials and the larger, upper temporal scales; auricular opening about as large as eye, oval, the tympanum deeply sunk. Mental large, its labial edge much more extensive than that of rostral; first labials meeting on median line of chin; second labials separated on median line of chin by a narrow elongated scale; two posterior lower labials widely separated from their fellows; scales bordering the corner of mouth opposite last upper labial not differentiated; on chin and throat very small conical granules; a pair of lateral nuchal folds run back from ear and jaw to meet a transverse nuchal fold, which is very distinct.

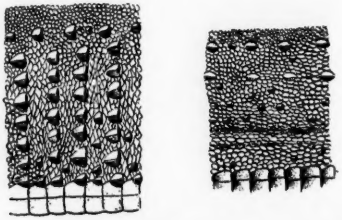

Fig. 2. Section of side of *Lepidophyma smithii* (left), and of *L. sylvatica* (right), to show tubercles.

Neck, and dorsal and lateral surfaces of body covered with conical tubercles usually with apical pits, varying somewhat in size, the tubercles separated from each other by minute intercalated granules; on each side of the median line is a row of somewhat oval, subtrihedral tubercles, separated by 4 or 5 rows of granules; granules lower on sides, larger, irregular; a well-defined lateral fold from axilla to groin; 30 rows of transverse plates on venter from breast to anterior anal scales; in the middle of abdomen, each row consists of 10 smooth plates, the outer somewhat smaller and somewhat raised (in the paratypes, young males show ventral plates bluntly keeled or with a tubercular elevation towards the posterior edge); 4 scales bordering anus, the median pair much enlarged; these preceded by a pair of differentiated scales, and these in turn preceded by 4 differentiated scales, the 2 outer smaller than inner. Lamellar formula for hand, 7, 11, 16, 18, 11; several of the lamellae are divided on median line of digit; formula for toes 8, 12, 18, 25, 17; certain of the lamellae are broken into 2 or 3 scales (third toe missing on left hind foot). Tail broken off and a new tail beginning to regenerate.

Tail covered with strongly keeled scales above and below, arranged in transverse series forming whorls; the dorsal scales smaller than lateral or ventral, so that proximally there are 4 rows forming a whorl on dorsal surface; on ventral surface there are 3; in the distal portion of the tail there

are 5 rows to each whorl dorsally, and 4 ventrally. The last series of each whorl much larger than other rows.

Scales on forearm flat, somewhat cycloid, larger than elsewhere on arm; other granules on arm slightly trihedral, subequal; scales on front of thigh, and a row on ventral edge of the shank largest; several strongly-differentiated, trihedral tubercles present on dorsal and posterior part of femur; a series of 11 femoral pores (in the young males the pores are distinctly better developed than in the female).

Color.—Scales of the dorsal surface of the head, light brown. Sides of head darker brown while upper and lower labials are black with the sutures bordered by yellow or cream; neck above brownish with some black flecks; an irregular dark line on side of neck from ear to some distance behind arm where it is lost in the blackish lateral coloration; a pair of dark lines on back more or less interrupted by yellow spots; a well-defined pair of yellow spots on neck in front of shoulders; another well-defined pair at base of tail; a few indistinct light spots or reticulations on sides and neck; chin and throat reticulated black and dirty, creamy white; transverse ventral plates each blackish brown anteriorly, dull cream or white on posterior half. Sides predominantly blackish with numerous cream-tipped tubercles.

Variation.—The younger paratypes are darker on the whole and the light marks are more strongly pronounced, especially the two at the base of tail which are very bright yellow cream; the two rows of spots on the back are clearly defined while the two dorsal dark stripes are less so; on the sides there are two series of light spots, the upper more or less transversely widened, the spots of the lower row lengthened; there are paired spots at irregular intervals on the dorsal surface of the tail; low on sides of tail is a series of strongly defined vertical yellow spots, the spots confined to the enlarged scale series of each whorl.

Measurements (in mm.) and data from type and paratypes.—Nos. 16259, 16260, 16261; Sex ♀, ♂, ♂; snout to vent, 61, 48, 44; snout to orbit, 7.2, 5, 4.5; snout to ear, 18, 10.8, 10; snout to foreleg 31.5, 20, 19; axilla to groin, 38, 20, 18.5; head length, 21.2, 13, 12.2; head width, 12.5, 8, 6.5; snout to nuchal fold, 30, 18, 17; arm, 26.5, 15.8, 15; leg, 33, 20.2, 17; tail, ?, 59 (tip regenerated), 64; femoral pores, 11-11, 13-13, 13-14.

Remarks.—This form may be easily differentiated from *Lepidophyma smithii* and *L. flavimaculatum* by the absence of lateral vertical rows of much enlarged trihedral tubercles on body (see fig. 2). The southern species are lowland forms. Most of the specimens of *smithii* in the EHT-HMS collection (eight specimens) were found under stones or debris in the edge of small streams in low mountains near Tonolá, Chiapas. The three types of *L. sylvatica* were obtained under fallen logs in pine and fir forest at an elevation of about 2300 m. The allied *Gaigea gaigeae* (Mosauer) is a highland form and seems to be associated with the limestones of central Hidalgo (I have collected more than a hundred specimens in the limestone environment and only one elsewhere).

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Studies on the Amphibian Digestive System, IV

The Effect of Diet on the Small Intestine of *Rana sylvatica*

By Ralph G. Janes

Introduction

THE alimentary canal in Salientia appears to be adapted to the changing dietary habits of the developing animal, for the larvae, which are considered to be vegetarian, have a longer small intestine than the carnivorous adults.

The length of the intestine is influenced by diet in various animals. In several species of tropical fishes, Hykes and Moravek (1933) found that those on an exclusively vegetable diet had a long intestine, and those on an exclusively meat diet a short one, while a mixed diet produced an intestine of intermediate length.

In Amphibia, previous studies have been largely confined to *Rana temporaria*. Babák (1903, 1904, 1905) found that the intestine was shorter in larvae fed on an animal-protein diet than in those fed on plant proteins, and concluded that a chemical factor derived from the food controlled the length of the intestine. At about the same time Yung (1904a, 1904b) described similar results from experiments with plant and animal foods, but concluded that greater mechanical irritation by the vegetable diet caused the increased intestinal length.

Results contradictory to those found in fishes and amphibians have been described for birds and mammals. Schepelmann (1907) and Wetzel (1929) report experiments with these groups.

In some preliminary experiments on the digestive tract of frogs, the author obtained certain data, particularly on the orientation and length relationships of the gut as influenced by diet, which differed somewhat from those of earlier workers. Further experimentation has yielded the results here presented, which have already appeared elsewhere in abstract form (Janes, 1937b).

Material and Methods

Two lots of eggs of *Rana sylvatica* were collected in a pond near East Irvington, New York, and one-half of each lot was placed in each of two aquaria. Upon hatching, one group of larvae was fed dried boiled beef liver, while the other was given boiled lettuce. The controls were larvae which underwent natural development in the same pond, collected in each of the stages of development studied in the experimental animals. The aquaria contained an abundance of food at all times, and the water was changed twice daily. Dead animals were removed as soon as they were discovered.

Measurements were made of the small intestines, removed and uncoiled immediately after killing the larvae. Twenty animals of each of the three groups were sacrificed, beginning with 22 mm. animals and continuing with 4 mm. increments to larval maturity (at about 44-52 mm.). Measurements were also made of twenty animals in each series at each of eight stages of metamorphosis. The definition of these stages may be found in an earlier paper (Janes, 1937a). These are briefly as follows: *Stage 1*, tadpole fully

grown; *Stage 2*, differentiation of thigh and shank; *Stage 3*, further development of hind limbs, fore limbs well-formed in the opercular cavity; *Stage 4*, one fore limb emerged; *Stages 5, 6*, and *7*, progressive metamorphic changes; *Stage 8*, the fully metamorphosed animal.

Additional animals for gross study were fixed during various stages of development in 70% alcohol or Helly's fluid.

Results

The tadpoles reared in the laboratory grew more rapidly during early larval development than those in the pond, because of higher laboratory temperatures. Intestinal measurements were started on laboratory animals before the eggs had hatched in the pond. The liver- and lettuce-fed animals grew at different rates, more rapid for those on liver.

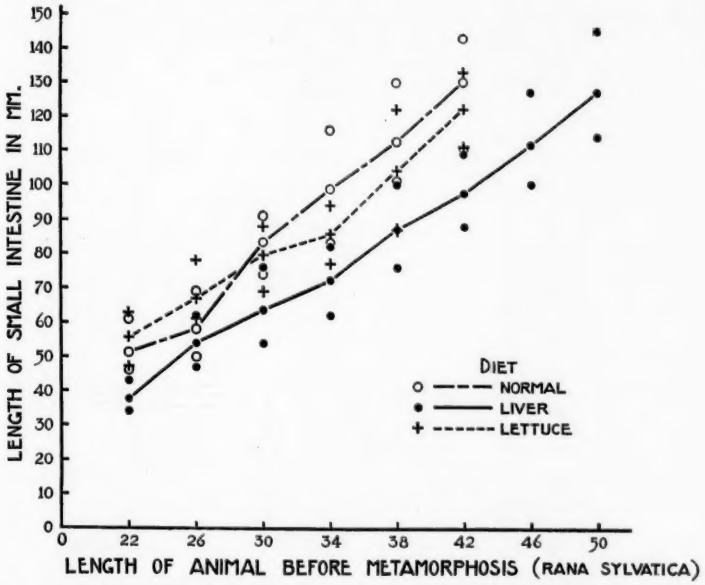

Fig. 1. Each point on the graph represents the average intestinal length of 20 animals with the maximum and minimum measurements indicated. Note that the normal and lettuce-fed animals reached maturity at the 42 mm. stage, the liver-fed ones at 50 mm. (Certain animals of each group became larger than these dimensions before commencing metamorphosis, but never as many as 20.)

The liver- and lettuce-fed larvae showed certain abnormalities while the control animals were normal. About 5% of the liver-fed ones and 70–80% of those fed on lettuce developed crooked tails. This malformation consisted of a bend at the base of the tail, more or less acute to the left or to the right, possibly due to an avitaminosis. The crooked tails handicapped the animals in feeding, and this may account for the large number of lettuce-fed animals which died during development.

The small intestine of liver-fed animals was generally filled with liver, the large intestine being ordinarily nearly empty. Both large and small intestines of the lettuce-fed tadpoles were ordinarily filled with food, and these animals generally left considerable excrement in the tank. The intestines of the control animals were usually distended with food and debris, which included some algae, food animals and leaves, together with considerable sand. Sand was less abundant in the intestines of young larvae than in those of older ones.

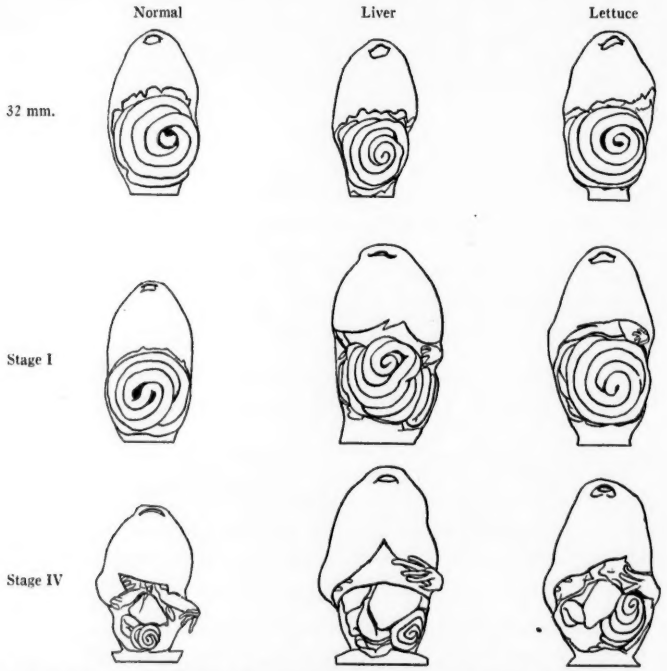

Fig. 2. Dissections showing orientation of gut in tadpoles of *Rana sylvatica*.

When the small intestines of 22 mm. animals were compared in the three groups, it was found that the lettuce-fed animals had the longest intestines while the liver-fed ones had the shortest (see fig. 1). After the 27 mm. stage and continuing until metamorphosis, the intestines of the controls surpassed in length those of the lettuce-fed individuals. The liver-fed animals averaged shorter intestines throughout larval development (see fig. 1), but some of the shortest intestines of control and lettuce-fed animals, in any particular group, were slightly shorter than the longest of the liver series. The differences shown in the graph prove to be statistically valid.

The liver-fed animals were the largest at maturity. Despite the relative shortness of their intestines, the greater size of these animals brought the

absolute lengths of their intestines nearly to those of the other two groups by the time of metamorphosis.

The coiling and orientation of the larval intestines of the three series were also considered. The small intestines of control larvae are coiled in a flat spiral as in other Ranidae, and lie slightly sinistrally. The intestines of the liver- and lettuce-fed animals were similarly coiled and oriented (fig. 2, 32 mm.). There were slight variations in the intestinal coiling, caused by differences in the length of the intestines in animals of similar size in the same or different series. The diameter of the small intestines also varied with the amount of food present and this slightly altered the arrangement. In general, the coiling was quite constant in all three series, the intestine was not coiled in two of the control animals. At the beginning of the metamorphosis (fig. 2, Stage 1) the coiling of the intestines was quite constant in the three groups, and during involution they followed a similar pattern as they shortened and uncoiled. Their orientation in Stage 4 is shown in fig. 2.

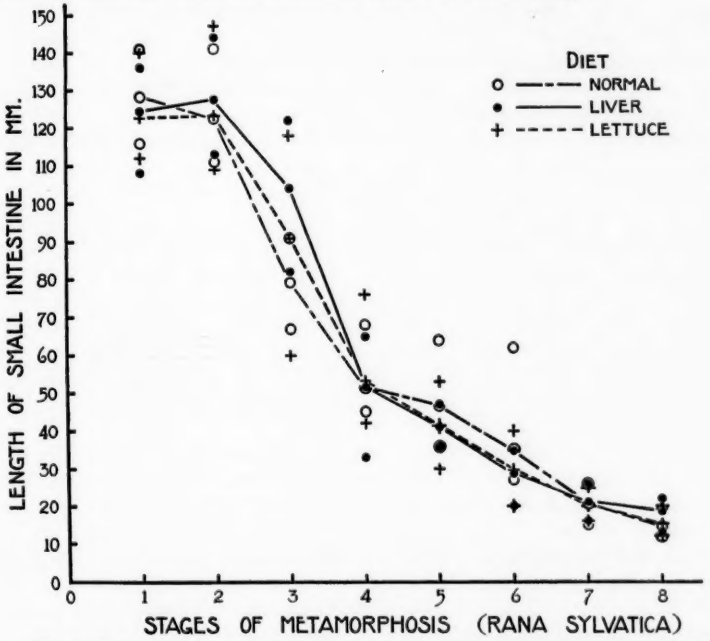

Fig. 3. Each point on the graph represents the average intestinal length of 20 animals with the maximum and minimum measurements indicated.

The animals of the different series varied considerably in size at the time of metamorphosis, while their intestines varied only slightly in length. The length of the normal larvae averaged 43.9 mm., that of the vegetarians 44.5 mm., and that of the carnivores 52.75 mm., while their intestines averaged 128.15 mm., 122.85 mm., and 124.4 mm. in length, respectively. The criteria for the stages of metamorphosis were based upon external characteristics

rather than size, and consequently animals of the same age and in the same series varied slightly in this respect. Beyond Stage 1 the intestines of the control animals had begun to shorten, while they were still lengthening in the liver- and lettuce-fed animals up to Stage 2. This additional intestinal length was correlated with further body growth of laboratory animals, although they had the metamorphic characteristics of Stage 2. After Stage 2, and continuing until metamorphosis was completed, the intestines of all three groups involuted at approximately the same rate (fig. 3). Until Stage 3 was reached, the rate of shortening of the intestines was a little the slowest in the liver-fed animals, and that in the control animals a little the fastest. Between Stages 3 and 4 the rates of involution converged so that at Stage 4 all three series showed the same intestinal length. Beyond Stage 4 the involution rates were markedly slowed and remained closely parallel to the end of metamorphosis. At Stage 8 there was a slight variation in body length of the three series of animals, and the average intestinal lengths closely approximated the average body lengths. Thus the newly metamorphosed control frogs averaged 15 mm. in length while their small intestines averaged 14.55 mm.; the lettuce-fed animals were 15.95 mm. long and their intestines 15.55 mm.; while the liver-fed animals were 18.85 mm. long and their intestines 18.7 mm. During metamorphosis the small intestine was reduced in length 88.64% in the control animals, 87.34% in lettuce-fed ones, and 84.96% in the liver-fed ones.

Discussion

Larvae of *Rana sylvatica* have been considered to be carnivorous by several investigators. Hinckley (1882) and Hay (1892) noted that tadpoles of this species would gnaw at amphibian eggs. Dickerson (1906) pointed out that these tadpoles act as scavengers by devouring dead animal matter in the pond. In the present study, it was noted that the larvae took both plant and animal food when offered simultaneously and would grow on either when offered alone. After finding both types of food in the alimentary canals of animals collected in the pond, it is concluded that the larvae are normally omnivorous.

As in other Ranidae, larvae of *Rana sylvatica* have a small intestine coiled in a flat spiral. This was true not only of the control animals, but also of those on experimental liver and lettuce diets. Babák (1903) was able to alter this pattern in *Rana temporaria* by feeding tadpoles a meat diet; he found that the intestinal coiling was greatly reduced, and from his figures its arrangement appears to resemble more closely that of the adult frog. The intestinal orientation of the animals used in the present experiments was not appreciably modified.

The alternation of intestinal length by diet appears to be verified. Tadpoles given only liver had shorter intestines, when comparable-sized animals were studied, than those on a lettuce diet. Lettuce, because of its cellulose content, probably produces more mechanical irritation, which presumably results in a longer intestine. In the larvae on this diet, the intestines generally contain a greater bulk of food than those of tadpoles on the liver diet, which may also have an effect on intestinal length. One would expect the control animals which were omnivorous to have an intestinal length intermediate be-

tween those on liver and lettuce diets; this was true during early development, but later on, when the tadpoles ingested a considerable amount of sand with their food, augmenting the roughage, their intestinal length was greater than in the lettuce-fed animals. It is concluded that mechanical irritation is a large factor in producing differences in relative intestinal length.

Babák (1905) belived that differences in intestinal length were produced by the chemical nature of the food taken. He noted that when he fed muscle from different invertebrates to different groups of larvae of *Rana temporaria,* a greater (inter-group) variation in intestinal length resulted than when he fed muscle from vertebrates. It is possible, however, that the variations resulted from difference in the digestibility of the muscles, rather than their chemical nature. A less easily digested food would have a tendency to accumulate, i.e., to fill the intestine, and thus cause a greater mechanical stimulation which would lead to the lengthening of the intestine. On the other hand, the variations might be due to differences in the coarseness of the foods themselves. If either of these interpretations is valid, Babák's experiments can be harmonized with the hypothesis that the intestinal length is governed, at least in part, by the mechanical irritation produced. Further experimentation is needed to evaluate the chemical factor postulated by Babák.

Elven (1928) suggested that the ingestion of bacteria might alter intestinal length. The effect of bacteria has not been considered in the present study, but presumably it was not an important factor since the water was changed twice daily and the tanks kept clean, thus reducing the bacterial flora to a minimum.

Although the intestinal length varied from series to series in developing larvae of the same size, in the mature larvae the average intestinal lengths were nearly equal, while their body lengths showed a greater degree of variation. During metamorphosis the intestines involuted at approximately the same rate, this rate slowing markedly after the appearance of the first forelimb. The animals were nearly of the same size at the end of metamorphosis, with intestines closely corresponding to the average length. Babák (1903) believed that diet-induced variations were both relative and absolute. From the present experiments, however, the differences in length caused by diet are seen to be only relative, and degree of differentiation of the larvae, rather than size, apparently governs absolute intestinal length.

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Notes on Snakes of the Genus *Salvadora* with a Redescription of a Neglected Mexican Species

By C. M. BOGERT

WHEN a study of the genus *Salvadora* Baird and Girard was undertaken in 1934, effort was made to examine all the material belonging to the group in collections within the United States. At that time only twenty-one specimens assigned to the species *mexicana* (Duméril and Bibron) could be assembled, and whereas two distinct patterns were represented in the series, data supplied with one loan indicated that both patterns were represented on specimens from Colima, Mexico. The presence of two obviously closely related forms in the same region being unlikely, and with the paucity of material available, I was led to make the erroneous statement only recently published (Bogert, 1939: 185) that "Although there is no correlated difference in scalation, two rather distinct patterns are found in this species."

Collections made in the state of Oaxaca, Mexico, during the winter months

of 1937 and 1938 by Mr. T. C. McDougall and generously presented to the American Museum contained specimens of the form without crossbars on the neck which I had referred to *Salvadora mexicana*. Later in 1938, Dr. William Beebe sent the museum a collection secured during the cruise of the *Zaca* which included a similar specimen from Oaxaca and I was prompted to investigate the situation more fully.

Re-examination of the material disclosed the fact that the specimen of the form without crossbars inadvertently included with a shipment of typical specimens from Colima was in reality from Acapulco, Guerrero, and it became apparent that the ranges of the two forms were distinct. Unfortunately it was too late to record this information in my paper on the genus *Salvadora* which appeared shortly afterward.

Meanwhile, Mr. James A. Oliver of the Museum of Zoology, University of Michigan, had drawn conclusions similar to my own from a study of material secured in Colima and Oaxaca by Dr. Norman Hartweg and himself. Upon receipt of my paper dealing with the genus, Mr. Oliver requested further data concerning the distribution of the two forms. Learning that I intended to rectify my mistake in assigning two patterns to the same species, he and Dr. Hartweg courteously lent their material and supplied additional notes taken in the field.

The activities of other collectors in Mexico, particularly Drs. E. H. Taylor, Hobart M. Smith and Mr. W. W. Brown, have made it possible to examine more adequate series, and now it is possible to demonstrate that two distinct species are represented in southwestern Mexico. Review of the literature discloses the fact that the Mexican form without crossbars on the neck possesses a valid name although it has long been confused with *Salvadora pulcherrima* (Cope), of Central America, and I failed to detect this in preparing my review of the genus.

Bocourt, in 1890, accurately described and depicted the Mexican form under the name "*Drymobius* (*Eudryas*) *pulcherrimus*." Boulenger, in 1893, repeated the error, and apparently Günther, in 1894, was similarly misguided since he lists specimens from Tehuantepec as well as from the type locality of true *pulcherrima*. Two years later Cope (1896: 203), in a discussion of hemipeneal characters, mentioned his *Drymobius pulcherrimus* (= *Salvadora pulcherrima*) with a footnote stating, "The species figured and described by Bocourt (Miss. Sci. Mexique, p. 725, Pl. XLIX, Fig. 3) is quite distinct. It is much larger, has but two preoculars, four bands instead of two, and is olive and brown instead of black and white with a green head. I propose to call it *Drymobius lemniscatus*." Unaccountably, Boulenger in the third volume of the catalogue, which was published shortly after Cope's paper, listed Cope's *lemniscatus* in the addenda as a synonym of *pulcherrima*. Thus the name applied by Cope has remained buried and I contributed to the misunderstanding by following Boulenger in assigning *lemniscatus* to the synonymy of *Salvadora pulcherrima*. My mistake is corrected in the synonymy listed below and references here included should be deleted from the synonymy for *pulcherrima* in my earlier paper (*supra cit.*).

Cope's indication unfortunately leaves *Salvadora lemniscata*, as it must now be called, without a definite type locality and without a designated type.

Bocourt (1890: 726), at the end of his description, states that "Le Muséum possède plusieur individus de cette especе, recueillis dans le Mexique occidental par F. Sumichrast." If a large specimen (1610 mm. long) described by Bocourt can be located in the Paris Museum, I would suggest that it be selected from the cotype series as the type. Meanwhile, the type locality "Mexique occidental" will stand, as given in the synonymy below, and all Mexican records for *Salvadora pulcherrima* should be deleted.

Salvadora lemniscata (Cope)

1890 *Drymobius* (*Eudryas*) *pulcherrimus* Bocourt (*non* Cope), Miss. Sci. Mex., Rep., livr. 12: 725, pl. 49, figs. 3, 3a-e.

1893 *Zamenis pulcherrimus* Boulenger, Cat. Snakes Brit. Mus., 1: 392; 3: 622. Günther (*partim*), Biol. Cent. Amer. Rept. and Batr., 1894: 123.

1896 *Drymobius lemniscatus* Cope, Trans. Amer. Philos. Soc., 18: 203, footnote. (Based on description given by Bocourt, 1890.) Type locality, "Mexique occidental."

1938 *Salvadora pulcherrima* Smith, Univ. Kansas Sci. Bull. 25: 230, pl. xxii.

1939 *Salvadora mexicana* Bogert (*partim*), Publ. Univ. Calif. at Los Angeles in Biol. Sci., 1: 184, pl. 4. (The plate depicts true *mexicana*.)

Material Examined.—Twenty-three specimens, including fifteen in the Museum of Zoology, from the state of Oaxaca: UMMZ Nos. 82524, Rancho Poso Rio (6 km. south of Tehuantepec); 82525–29, vicinity of Tehuantepec; 82530–33, San Pedro Mountain (24 km. west of Tehuantepec); 82534–35, Quiengola Mountain (8 km. northwest of Tehuantepec); 82536–37, between Quiengola Mountain and Tehuantepec; 84482, Tapanatapec; also six from Oaxaca in the American Museum of Natural History, AMNH Nos. 58363, 61756–57, Tehuantepec; 51755, Port Guatulco Bay; 19638, Salazar, Tehuantepec River; 19525, Salina Cruz; one from the state of Guerrero, AMNH No. 19627 from Acapulco; and one from the state of Chiapas, EHT-HMS No. 4669 from San Ricardo.

Redescription.—Head scutellation normal except that the rostral projects feebly at its sutures with the first labials, the anterior nasals and the internasals. Two internasals and two prefrontals; internasal suture shorter than prefrontal suture. Frontal longer than its distance from the end of the snout, about as long as the parietals. Supraocular as long as the frontal. Nostril between two nasals; loreal varying in shape from subtriangular to quadrangular, a single specimen with the loreal divided on one side. Preocular single (rarely with a suture that partly divides it), extending on the top of the head to an apex which usually touches the common suture of the prefrontal and frontal. Postoculars uniformly 2; temporals usually 2+2+2+2, rarely 2+1+2+2 or 2+2+2. Supralabials normally 9 (two specimens have 8 on one side), the fourth, fifth, and sixth, or rarely the third, fourth and fifth entering the orbit (the posterior upper corner of the third or fourth may barely reach the orbit); infralabials 10 to 13, most commonly 11 or 12, the first pair meeting on a common suture behind the mental, 5 or 6 in contact with the anterior chin-shields. Posterior chin-shields longer than anterior pair, separated by one slender scale usually followed by two pairs of slender scales.

Variation in ventral and caudal counts is not extensive as shown by the following figures (averages in parentheses); ventrals, thirteen males, 196–206

(201.1); ten females, 200–205 (202.6); anal undivided on one specimen, divided on all others; caudals, ten males with tails complete, 132–146 (136.3); seven females with tails complete, 129–141 (134.6). Dorsal scales with double apical pits, slightly decreasing in size toward the vertebral row; disposed in 17 rows anteriorly and 13 just in front of the vent.

FORM.—A slender species with head distinct from neck. Eye large, its diameter equal to its distance from the nostril. The ratio of tail to total length varies from .31 to .33 in males and from .31 to .32 in females, but averages .32 for each sex with no evidence of sexual dimorphism. The species exceeds all other members of the genus in size; the largest specimen, from Port Guatulco Bay, is a female measuring 1615 mm.

Hemipenis noncapitate, undivided, sulcus not bifurcate. Basal portion armed with four enlarged hooks, the largest adjacent to the sulcus. These hooks are followed by strong spines which diminish in size distally and merge with reticulate calyces with denticulated edges on the distal half.

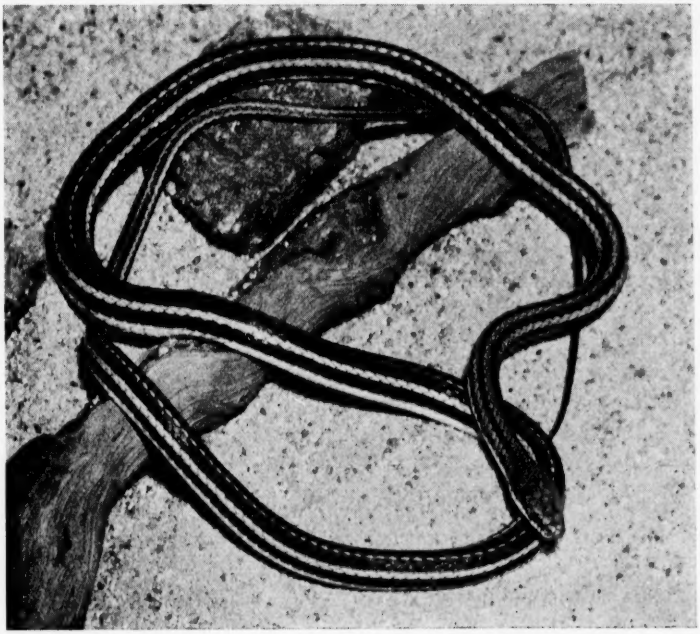

Fig. 1. *Salvadora lemniscata* (Cope), AMNH No. 58363, from Tehuantepec, Mexico. From life, approximately X ⅓.

PATTERN.—On the body there are four longitudinal dark stripes (two on either side of a light vertebral stripe) which extend from near the end of the tail to the occiput. At midbody the dark stripes are brown, those flanking the vertebral row widest, the lower pair darkest. On the neck the four dark stripes become black and diminish in width so that each occupies two half

scale-rows, whereas toward the head, the light stripes of the ground color broaden, and change from the pale yellow of midbody to light gray. On the neck the vertebral stripe embraces five scale-rows, but posteriorly it diminishes in width to include only the centers of the scales of the median row. Top of head pale brownish gray, the edges of each plate narrowly margined with black, the sutures thus appearing prominent. Upper margins of supralabials black. An irregular black band extends from the postoculars through the anterior temporals to include only the lower scale of the posterior pair. Belly, including ventrals and the lower half of the contiguous scale-rows, throat and chin, immaculate cream color. Juveniles are similar to adults.

RANGE.—The localities listed for the material examined indicate that the range of the species is confined to extreme southern Mexico from near San Ricardo in Chiapas, westward through southern Oaxaca and north to Acapulco in Guerrero.

HABITS AND HABITAT.—Mr. Paul Rüthling, who in 1919 collected three of the specimens of *S. lemniscata* now in the American Museum collection, states in his field notes that one "was found near the beach east of Acapulco, under a fallen palm stump." Another from Salina Cruz was taken "on stones by the roadside on a semi-arid rocky slope facing the ocean," and the third was found in "dead brush in a dry sandy terrain near Salazar." Dr. William Beebe records that the specimen taken at Port Guatulco Bay was "caught one-half mile inland on trail. It had a lizard partially swallowed which got away." Dr. Norman Hartweg and Mr. James A. Oliver record in their field notes that near Tehuantepec, "these extraordinarily speedy snakes were frequently seen but were difficult to catch alive in the xerophytic scrub vegetation. One was captured while it was pursuing a *Cnemidophorus guttatus immutabilis*." Two other specimens secured by them contained lizards identified by Mr. Oliver as *Cnemidophorus d. deppii* and *Cnemidophorus* sp. and a specimen taken by Rüthling at Salazar, contained nematodes and the digested remains of a teiid lizard.

It is of interest to note that all food records reported for snakes of the genus *Salvadora* indicate that under natural conditions their diet consists solely of lizards. Furthermore, when it has been possible to identify the lizard, it has proved to be some species of *Cnemidophorus*. Probably *Ameiva* also is eaten. *S. lemniscatus* ate *Anolis* in the laboratory, but never could be induced to seize the lizard until the *Anolis* made rapid movements in the cage. Invariably the lizard was caught while in motion, whereas if it stopped abruptly the snake was unable to locate it. *Salvadora lemniscata*, as well as other species of the genus, seems to depend exclusively upon its sight in locating and capturing its prey, the tongue-Jacobson's organ mechanism having no apparent rôle in the feeding activity.

NOTES ON *Salvadora mexicana* AND ITS RELATIONSHIPS

A total of twenty-nine specimens (seventeen males, twelve females) now available makes it possible to add several localities to those included in the published list (*op. cit. supra*), all of which refer to *mexicana* with the exception of those from Oaxaca. New locality records include: Villa Alvarez, and Hacienda Paso del Rio (Oliver 1937: 19) in Colima; Hacienda El Sabino in

Michoacan; 133 km. south of Huajintlan in Morelos; Mexcala, Organos, El Treinte, Pato Blanco, and "Omilteme and Sierra de Burro," El Limoncita, Totolopam, in Guerrero. The Guerrero, Morelos and Michoacan records are based upon specimens in the collections of Drs. E. H. Taylor and Hobart M. Smith, and the Museum of Comparative Zoology.

The Guerrero records are of especial interest since it is in this state that the ranges of the two forms are contiguous and here intergradation might be expected between *mexicana* and *lemniscata*. Although Rüthling secured typical *lemniscata* near the beach at Acapulco he also collected typical *mexicana* "east of Acapulco" but unfortunately he does not state how far to the east. Thus, there is no evidence beyond these inexact locality data that the ranges of the two forms overlap. Furthermore, there is no indication that intergradation occurs in morphological characters since there are several contrasting characters that serve to distinguish the two species. These differences may be tabulated (scale characters are given as averages, extremes in parentheses) as follows:

	mexicana	*lemniscata*
Pattern	Spots present on outer ends of ventrals anteriorly. Crossbars and mottled pattern on neck. A dark stripe continued through each parietal and supraocular.	Belly immaculate. Four distinct stripes on neck, which is not mottled. Top of head with only the margins of the plates darker. No stripe through the parietal or supraocular.
Ventrals: males	186.9 (182–191)	201.1 (196–206)
females	188.7 (185–192)	202.6 (200–205)
Caudals: males	132.6 (125–141)	136.3 (132–146)
females	133.9 (127–140)	134.6 (129–141)
Average size of ten largest specimens:		
males	1246 mm.	1460 mm.
females	1083 mm.	1423 mm.
Maximum sized individual	1340 mm. (male) (EHT–HMS No. 4860, from Michoacan)	1615 mm. (female) (AMNH No. 61755, from Oaxaca)
Ratio of tail to total length:		
males	.33 (.32–.33)	.32 (.30–.33)
females	.33 (.31–.36)	.32 (.31–.32)

From these data it may be observed that scarcely any difference between the sexes exists in either form, a condition characteristic of all species in the genus. The species *lemniscata*, with a more restricted range, may be regarded as the more primitive of the two, and *mexicana* is almost certainly a direct derivative of it.

Maxillary Dentition of *Salvadora*

No adequate description of the dentition of *Salvadora* has ever appeared. Cope (1900: 817) merely states that the teeth are longer posteriorly. Boulenger (1893: 379) included *Salvadora* under the genus *Zamenis*, apparently having based his description of the maxillary dentition largely upon Old World forms currently referred to *Coluber*. Certainly my findings with respect to *Salvadora* do not agree with his since he describes the teeth as "increasing in size posteriorly, forming a continuous series or the two last

separated from the others, by a very narrow interspace." Twenty-three specimens examined, including all six forms of *Salvadora*, indicate that the anterior teeth vary from 9 to 17, slightly increasing in size posteriorly, and invariably followed after a diastema by 3 enlarged teeth. The variation within the various forms is tabulated below, a plus sign being used to indicate the diastema:

MAXILLARY TEETH IN *Salvadora*

Form	Museum No.	Locality	Counts
pulcherrima	USNM, 38150	Pacaca, Costa Rica	17+3
lemniscata	AMNH, 61756	Tehuantepec, Oaxaca	14+3
"	" 61755	Port Guatulco Bay, Oaxaca	14+3
"	" 19638	Salazar, Oaxaca	14+3
"	" 61757	Tehuantepec, Oaxaca	15+3
mexicana	AMNH, 19626	E. of Acapulco, Gro.	14+3
"	" 19634	Manzanillo, Colima	15+3
"	" 19635	Tecoman, Colima	14+3
"	" 12782	Perequillo, Colima	15+3
"	" 19637	Tecoman, Colima	15+3
g. grahamiae	AMNH, skull	Without data	10+3
"	" 32432	San Marcos, Texas	10+3
"	" 3416	Guadalajara, Mexico	10+3
"	" 3418	Without data	11+3
"	" 19528	Guadalupe, D.F., Mexico	9+3
"	" 19629	Cholula, Puebla, Mexico	9+3
g. hexalepis	AMNH, 4717	Without data	11+3
"	" 9861	Las Vegas, Nevada	11+3
"	" 15070	San Pedro Valley, Arizona	12+3
"	" 4916	Sonora, Mexico	12+3
g. virgultea	AMNH, 20655	San Bernardino, California	10+3
"	" 9373	Sierra Madra, California	10+3
"	" 9225	Pasadena, California	10+3

Amaral (1927: 29), in his description of *Leptodrymus clarki* (= *Salvadora pulcherrima*), described the maxillary teeth of his type specimen as "16+1 (17)" apparently overlooking the 2 posterior teeth. The species *pulcherrima* has been regarded as the most primitive representative of the genus on the basis of the weakly developed rostral as well as upon zoögeographical grounds (Bogert, *op. cit.*: 217). The fact that the species possesses more teeth than any other species of *Salvadora* bears out this conclusion. Furthermore the progressive modifications from the ancestral *Dryadophis* (*Eudryas, auct.*) with 18 to 29 teeth (*fide* Stuart, 1932: 9) through the various forms, *pulcherrima, lemniscata, mexicana* and *grahamiae* with its subspecies *hexalepis* and *virgultea*, are fairly well correlated with a reduction in the number of teeth. This correlation is not entirely satisfactory in the subspecies of *grahamiae*.[1] However, there are insufficient specimens available to determine whether the minor variations in tooth-counts are of any phylogenetic significance, or whether the differences are of importance in separating the subspecies of *grahamiae*. Obviously differences in maxillary dentition are of considerable value in determining the relationships of species.

[1] The writer remains unconvinced that *Salvadora bairdii* (Jan) is a valid species. The chief difference between this reputed form and typical *grahamiae* lies in the pattern and this difference is not well correlated with any character of the lepidosis when a sufficient number of specimens is examined.

Key to Snakes of the Genus *Salvadora*

A. Tail approximately one-third total length; temporals 2+2+2; normally three labials entering the orbit
  B. Postoculars three; two longitudinal dark stripes on body; maxillary teeth 20 ..... *pulcherrima* (Cope)
  BB. Postoculars two; four longitudinal stripes at midbody; maxillary teeth 17-18
    C. Stripes continued to occiput; ventrals immaculate, 196-206 in number ..... *lemniscata* (Cope)
    CC. Stripes interrupted anteriorly, crossbars on neck, spots on outer margins of anterior ventrals; ventrals 182-192 in number..... ..... *mexicana* (Duméril and Bibron)

AA. Tail approximately one-fourth total length; temporals normally 2+3, no more than two labials entering the orbit (none, one or two)
  B. Loreal normally single; supralabials normally eight; posterior chin shields in contact or separated by one small scale .... *grahamiae grahamiae* (Baird and Girard)
  BB. Loreal normally divided; supralabials normally nine; posterior chin shields separated by two or three small scales
    C. Surface of head gray; a wide, light vertebral stripe, paralleled by a darker stripe on each side, each darker stripe broken into two stripes on the posterior two-thirds of the body and tail; ventrals average 200.6 (189-212) ..... *g. hexalepis* (Cope)
    CC. Surface of head brown; a narrow, light vertebral stripe paralleled by a brown stripe on each side, each brown stripe indistinctly broken on posterior third of body; ventrals average 193.7 (187-200). *g. virgultea* Bogert

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Annulus Formation in Scales of the Common Shiner, *Notropis cornutus chrysocephalus* (Rafinesque)

By Nelson Marshall

SINCE Hoffbauer (1898-1900) observed in the scales of the carp concentric rings which he supposed to be growth rings, the technique of determining the age of fishes by counting the annuli has been used extensively. Many complications arise, however. For example, Blair (1937) described a definite but rather difficult distinction between winter marks and spawning marks in salmon scales. Hansen (1936) has shown that the annulus of the white crappie scale does not form in the winter but in early summer. Such complications have led to uncertainty regarding the application of the age determination technique. A study of the interpretation of the scales in relation to life history is therefore necessary for each type fish before its age may be determined from scale markings. From this standpoint such a study was undertaken on the scales of *Notropis cornutus chrysocephalus* (Rafinesque).

The author is grateful to Dr. John W. Price and Mr. E. N. Warner, both of the Department of Zoology and Entomology, Ohio State University, for advice and photographic work respectively. The Ohio Division of Conservation, through its representative, Mr. E. L. Wickliff, very kindly furnished the material and related data.

The fish studied, totaling 146 specimens, were taken largely from station 5, a selected location in Blacklick Creek in central Ohio. Collections had been made over a two year period (Sept., 1936, to May, 1938) at approximately monthly intervals, with a few exceptions. Available collections taken at station 3 (a location more toward the head of the stream) during May and June, 1937, and at station 8 (more toward the mouth) during May and July, 1937, were used for additional observations.

The youngest fish studied had an average length of 41 mm. These were taken in September of their first year, which, in the light of Brancamp's study (1938, unpublished) on the chronological appearance of scales in this species, seemed to be the earliest month when one might expect first season fish to be fully scaled. To the extent available, five first year fish were taken from each monthly collection thereafter. To obtain older age groups three medium-sized and three large-sized fish were selected at random whenever such were present in the collections.

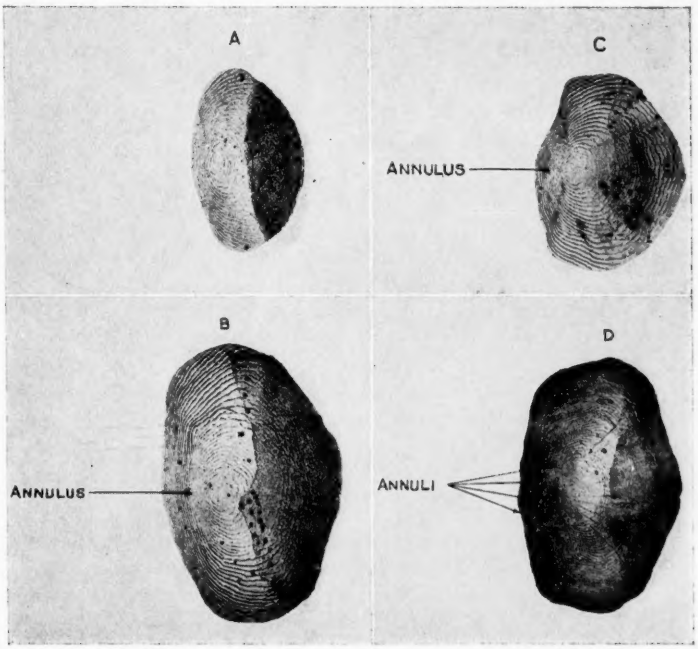
For permanent scale mounts Farrant's medium was used with considerable success. With this medium it was found unnecessary to disk the cover slips to prevent evaporation during the course of the study.

Whenever possible scales were taken along an imaginary line running dorso-ventrally from the anterior end of the dorsal fin and within 6 scales above and 6 below the lateral line, exclusive of lateral line scales, thereby attempting to conform to current field practices. On the other hand, this region as well as large portions of the body were often devoid of scales, especially in the smaller fish, probably due to handling. This condition sometimes necessitated the removal of scales from a great variety of places on the

body surface. In every such case, all non-regenerated scales taken from a single fish were similar in their number of annular markings.

Scales were studied with both a scale machine and a compound microscope.

The anterior field of the scale of *Notropis cornutus chrysocephalus* is much smaller than the posterior field, with much more crowded circuli (see fig.). This is a characteristic of the scales of several genera of cyprinoid fishes (Cockerell and Allison, 1909, Cockerell and Moore, 1910). The crowded anterior field was found to be the only region in which annular markings could be determined satisfactorily, although sometimes the posterior field could be used as a check.



Scales of *Notropis cornutus chrysocephalus*

A. Scale from fish collected February 23, 1937. No annulus present. Size of scale 1.43 mm x 2.30 mm. Length of fish from which scale was taken, 41 mm. B. Scale from fish collected February 23, 1937. One annulus present. Size of scale 2.30 mm. x 3.37 mm. Length of fish from which scale was taken, 67 mm. C. Scale from fish collected July 15, 1937. One annulus present. Size of scale 1.82 mm. x 2.34 mm. Length of fish from which scale was taken, 54 mm. D. Scale from fish collected May 10, 1938. Three annuli complete. Fourth in the process of formation. Size of scale 3.84 mm. x 5.50 mm. Length of fish from which scale was taken, 104 mm.

Scales of the young fish showed no modification of the circuli until in the late spring. (Tables I, II). At this time a pattern developed in which the circuli break off, branch, anastomose, and are generally irregular. This annulus, as contrasted with other occasional irregularities, continues for the entire dorso-ventral length of the scale (see fig.). Successive similar mark-

TABLE I: SUMMARY OF OBSERVATIONS

Collection Dates Station 5	Standard Lengths of Fish in mm. Age Groups[1]									
	0	(1)	1	1+	(2)	2+	(3)	3	3+	(4)	4+
Sept. 18, 1936	40	.....	...	.....	...	73	...	...	...	...	...
	41	.....	...	.....	...	82	...	...	105	...	...
	43, 43	.....	...	.....	...	97	...	...	...	...	...
	50	.....	...	.....	...	...	...	...	...	...	...
Sept. 9, 1937	38	.....	...	63	...	...	...	...	...	...	...
	39, 39	.....	...	76	...	...	...	...	...	...	...
	40	.....	...	.....	...	...	...	...	...	...	...
	41	.....	...	.....	...	...	...	...	...	...	...
Oct. 14, 1937	32	.....	...	.....	...	...	...	...	...	...	...
	38	.....	...	70	...	101	...	...	...	...	...
	40	.....	...	73	...	...	...	...	...	...	...
	45, 45	.....	...	.....	...	...	...	...	...	...	...
Oct. 11, 1937	35	.....	...	.....	...	...	...	...	...	...	...
	39	.....	...	.....	...	71	...	...	...	...	...
	41	.....	...	.....	...	84	...	...	...	...	...
	43	.....	...	.....	...	89	...	...	...	...	...
	48	.....	...	.....	...	...	...	...	...	...	...
Nov. 19, 1936	39, 39	.....	...	.....	...	...	...	...	116	...	...
	41	.....	...	72	...	90	...	...	122	...	...
	44	.....	...	.....	...	...	...	...	...	...	...
Nov. 9, 1937	34	.....	...	.....	...	...	...	...	...	...	...
	38	.....	...	76	...	...	...	...	...	...	...
	41	.....	...	.....	...	...	...	...	...	...	...
	42	.....	...	.....	...	...	...	...	...	...	...
	43	.....	...	.....	...	...	...	...	...	...	...
Dec. 28, 1936	34	.....	...	.....	...	...	...	...	...	...	...
	35	.....	...	82	...	99	...	...	...	...	...
	37	.....	...	86	...	101	...	...	...	...	...
	42	.....	...	.....	...	...	...	...	...	...	...
	44	.....	...	.....	...	...	...	...	...	...	...
Dec. 22, 1937	35	.....	...	.....	...	...	...	...	...	...	...
	42, 42	.....	...	.....	...	...	...	...	...	...	...
	47	.....	...	.....	...	...	...	...	...	...	...
	48	.....	...	.....	...	...	...	...	...	...	...
Feb. 23, 1937	37	.....	...	.....	...	...	...	...	...	...	...
	40	.....	...	61	...	...	...	...	102	...	...
	42, 42	.....	...	66	...	...	...	...	102	...	...
	49	.....	...	67	...	...	...	...	114	...	...
Feb. 3, 1938	35	.....	...	.....	...	...	...	...	...	...	...
	42	.....	...	72	...	...	...	...	...	...	...
	46	.....	...	74, 74	...	...	...	...	...	...	...
	51, 51	.....	...	.....	...	...	...	...	...	...	...

TABLE I: CONTINUED

Collection Dates Station 5	Standard Lengths of Fish in mm. Age Groups[1]										
	0	(1)	1	1+	(2)	2+	(3)	3	3+	(4)	4+
March 23, 1937	36	.....	...	.....	...	...	...	...	...	...	...
	39	.....	...	.....	...	...	...	...	...	...	...
March 4, 1938	37	.....	...	.....	...	...	...	...	...	...	...
	38	.....	...	87	...	88	...	...	...	...	...
	45, 45	.....	...	.....	...	97	...	...	...	...	...
	47	.....	...	.....	...	...	...	...	...	...	...
April 22, 1938	35	.....	...	.....	...	...	...	...	...	...	...
	36	.....	...	.....	...	...	...	...	...	...	...
	38	.....	...	.....	...	...	...	...	...	...	107
	39	.....	...	.....	...	...	...	...	...	...	...
	40	.....	...	.....	...	...	...	...	...	...	...
May 6, 1937	25	41	44	.....	...	65	91	...	...	...	...
	38	48	...	.....	...	67	99	...	...	...	...
	.....	.....	...	.....	...	...	102	...	...	...	...
May 10, 1938	.....	46	...	.....	77	...	86	...	104	...	...
	.....	.....	...	.....	85	...	...	...	...	...	...
June 9, 1937	.....	.....	55	.....	...	...	...	...	...	...	...
	.....	.....	56	.....	...	...	...	...	...	...	...
July 15, 1937	.....	.....	...	47	...	...	...	93	91	...	...
	.....	.....	...	50	...	...	...	...	...	...	...
	.....	.....	...	51	...	...	...	...	...	...	...
	.....	.....	...	52	...	...	...	...	...	...	...
	.....	.....	...	56	...	...	...	...	...	...	...
August 12, 1937	.....	.....	...	50	...	76	...	...	...	...	...
	.....	.....	...	56	...	79	...	...	...	...	...
	.....	.....	...	58	...	80	...	...	...	...	...
	.....	.....	...	.....	...	105	...	...	...	...	...
Collection Dates Station 3											
May 5, 1937	.....	48	...	.....	71	...	103	...	...	...	...
	.....	49	...	.....	80	...	...	...	...	...	...
July 15, 1937	.....	.....	...	60	...	89	...	...	...	...	...
	.....	.....	...	75	...	...	...	...	...	...	...
Collection Dates Station 8											
May 17, 1937	.....	39, 39	...	.....	53	...	92	...	...	...	...
	.....	41	...	.....	69	...	...	...	...	...	...
	.....	46	...	.....	...	...	...	...	...	...	...
June 17, 1937	.....	40	41	55	...	...	...	...	...	...	...
	.....	.....	52	.....	...	...	...	...	...	...	...
	.....	.....	62	.....	...	...	...	...	...	...	...

[1] Key to column headings:
0—No annulus.
(1), (2), (3), (4)—Number of the annulus in the process of formation.
1. 3—Number of annulus just completed.
+—Further growth follows the last annulus—indicated by number.

ings (second, third, and fourth having been observed) were formed at the same time of the year in older fish; and comparable markings did not occur at any other time (Tables I, II). There are areas in which the circuli are more crowded or more spread than usual. These, however, are often absent, and do not occur with enough seasonal regularity to be of significance as annular markings. Rather, it is the late "spring marking," a pattern of irregular circuli which develops approximately in May, that may be considered as an annulus, in view of its regular yearly occurrence.

TABLE II: RECORD OF SCALE DEVELOPMENT OF THE 1936 HATCH

Scale Reading	Collection Date	No. Specimens	Av. Stand. Lgth. of Fish in mm.
0	Sept. 18, 1936	5	43.4
0	Oct. 14, 1936	5	40.0
0	Nov. 19, 1936	4	40.8
0	Dec. 28, 1936	5	38.4
0	Feb. 23, 1937	5	42.0
0	Mar. 23, 1937	2	37.5
0	( )	2	31.5
(1)	(May 6, 1937)	2	44.5
1	( )	1	44
1+	June 9, 1937	2	55.6
1+	July 15, 1937	5	51.2
1++	Aug. 12, 1937	3	54.7
1++	Sept. 9, 1937	2	69.5
1+++	Nov. 9, 1937	1	76
1+++	Feb. 3, 1938	3	73.5
(2)	May 10, 1938	2	81.0

[1] Key to symbols:
0—no annulus present
(1)—first annulus forming
1+—a little normal growth following first annulus
1++—medium amount of normal growth following first annulus
1+++considerable amount of normal growth following first annulus
(2)—second annulus forming

Scale readings were made independently of a knowledge of the length of the fish. From the average lengths of all fish sampled in each annular group (Table III) it is seen that the groups with higher annular counts fall into correspondingly greater length groups. This demonstrates a general consistency in such scale readings.

TABLE III: AVERAGE STANDARD LENGTHS OF FISH IN ANNULAR GROUPS

Length Range, mm.	Average Length, mm.	No. Spec.	Number Annuli
25-51	41	63	0
39-87	59	42	1
53-105	83	25	2
86-122	102	16	3
104-107	105.5	2	4

The period of annulus formation is also the breeding season in the adult fishes. However, those fish forming their first annulus average 43.5 mm., which is considerably smaller than the shortest length at which Ball found this species to be sexually mature (60 mm. Cf. Table IV). Spawning marks as such and distinct from the spring marks were never observed.

The following observations by Ball (1937, unpublished) on the feeding of the common shiner in Blacklick Creek are of interest. He determined this species to be an omnivorous feeder, using all types of available fish food.

It does not hibernate, and although the amount of food taken in the winter months is relatively small, food was found in the stomachs at all seasons, and fat bodies were present in the fish throughout the year (the sampling was done during an extremely mild winter). A large portion of the diet is of insects, though plant material is taken freely at certain times, the kind of food depending on its seasonal abundance. Ball found no cessation of feeding during the breeding season.

TABLE IV: LENGTH MATURITY CHART, DATA FROM R. C. BALL

Number Spec.	Stand. Males Length, mm.	Stage Maturity	Stand. Females Length, mm.	No. Spec.
9	0-64	Immature	0-60	7
3	65-76	Doubtful	60-74	7
9	77-120	Mature	75-120	12

Available statistics throw no light on the exact trend of available food for this species, but general observations indicate, as expected, a tendency for the supply to increase steadily during the spring and early summer. Apparently the annulus is forming at the onset of a reasonably good, probably an abundant, food supply. Also, in the late spring the temperature is steadily rising. Obviously, the circuli of this season are being formed in a transition period from the winter to the summer season, when the fish must undergo marked physiological and metabolic adjustments which may be the chief causative factors for these circuli developing in irregular patterns.

SUMMARY

The scale of *Notropis cornutus chrysocephalus* has an anterior field much narrower than the posterior and with much more crowded circuli.

Each year in the late spring, approximately May, a mark forms, consisting of circuli arranged in irregular patterns for the entire dorso-ventral length of the anterior region. Due to its annual occurrence, this may be considered an annulus.

Areas elsewhere, in which the circuli are more concentrated or more spread than the average, are sometimes to be seen, but with no regularity or seasonal correlation which might give them significance as annular markings.

The spawning season, coinciding as it does with the time of formation of the spring or annular marking, might have some effect upon it, but it is to be noted that fish forming their first annulus are not yet sexually mature. No spawning marks as such, distinct from the annulus, were observed.

The annulus forms during a transitional period from winter conditions to spring conditions when the temperature is rising. At this time food is probably abundant and increasing, and the fish is undergoing adjustments including an increase in metabolic rate and growth rate in response to seasonal changes.

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A Method for Measuring the Food Preference of Trout

By A. D. HESS AND J. H. RAINWATER

THE kinds of natural food eaten by a given species of fish are commonly determined by examining stomach contents. Such data, however, cannot be used as a measure of food preference unless quantitative methods are applied. The measurement of the relative preference given to different kinds of food organisms by a given species of fish must be based on two things: 1, the relative numbers of these organisms eaten by the fish, and 2, the relative numbers of these organisms available.

Dividing the first ratio by the second will give the measure of preference. Thus, if mayflies and stoneflies are available in a ratio of 2 to 1 respectively and the numbers eaten by the fish are in the same ratio, there is an equal preference for each organism (mayflies, 2/2=1; stoneflies, 1/1=1); but if four times as many mayflies as stoneflies are eaten, the preference ratio becomes 2 to 1 in favor of the mayflies (mayflies, 4/2=2; stoneflies 1/1=1).

The accuracy of this measure of preference, then, depends upon the accuracy of the methods we use for determining the number of organisms available and the number eaten by the fish. This paper presents a method for determining the relative numbers of organisms eaten by fish, with special reference to the eastern brook trout, *Salvelinus fontinalis.*

If all organisms eaten by fish were digested at the same rate and passed through the alimentary tract at the same rate, examination of the stomach contents would yield directly a measure of the relative numbers eaten. However, it seems reasonable that soft-bodied organisms, such as many dipterous larvae, might be digested and passed through the alimentary tract much more rapidly than heavily chitinized forms, such as many of the larger stonefly nymphs. If this is true, it must be taken into consideration in evaluating the stomach contents.

The following experiment was made to determine if such a difference in the rate of digestion does occur. Fingerling brook trout of hatchery stock ranging in total length from about 9 to 11 cms. were held in hatchery troughs for two days without feeding. Then, by means of forced feeding, each fish was given one each of the food organisms being tested. To do this, the organism was taken in a slender forceps and carefully inserted through the esophagus into the stomach of the fish. This method was apparently completely effective. Fish kept in pans for a short while after feeding did not regurgitate, and stomachs taken a few hours after feeding showed all organisms present.

The following organisms were used in the experiment:

1. *Acroneuria,* a large stonefly nymph with the entire body heavily chitinized.
2. *Hydropsyche,* a caddis fly larva with the head capsule and thorax heavily chitinized.
3. *Chironomous,* a midge larva with only the head capsule heavily chitinized.
4. *Chaoborus* (*Corethra*), a phantom midge larva, without heavy chitinization.

Three separate lots were run, No. 1 on November 5, No. 2 on November 11, and No. 3 on November 21. In lot 1, each fish was given one *Hydropsyche* and one *Chaoborus;* in lot 2, each fish was given one *Acroneuria,* one *Chironomous,* and one *Chaoborus;* in lot 3, each fish was given one *Acroneuria.* This last lot was run to determine the complete time required for *Acroneuria* to pass through the stomach. Unfortunately, the temperature dropped to 1.9° C. at the end of the experiment, bringing the digestive activity almost to a standstill.

The results of the experiment as shown in the accompanying table indicate a marked difference between the rate of digestion of the soft-bodied and that of the heavily chitinized forms. The stonefly nymphs apparently resisted the initial stages of digestion because of the protection from digestive enzymes afforded by the heavy exoskeleton. They also remained in the stomach longer than the soft-bodied forms after all effective digestion had taken place; a few sclerites from the exoskeleton were still found in some of the fish stomachs ninety-five hours after feeding. It is possible that continued feeding might cause these undigestible parts to move through the alimentary tract more rapidly. The important part played by temperature is indicated by the difference between the rate of digestion of *Chaoborus* run at 11° C. and that run at 7° C. Digestion of the soft-bodied forms proceeded quite rapidly, being well under way at the end of five hours at a temperature of 11° C.

Identification at later periods was possible only from the undigested hard parts. The organisms passed through the stomach in about half the time it took them to pass through the entire alimentary tract.

TROUT-FEEDING EXPERIMENT

Lot	Date	No. of Fish	Temp. Cent.	Time*	% Organisms Still in Stomach			
					Acroneuria	*Hydropsyche*	*Chironomous*	*Chaoborus*
1	Nov. 5	5	11.3	5		100		100
		5	11.3	17½		60		20
		10	11.6	22		40		0
2	Nov. 11	5	6.7	6	100		100	100
		10	7.7	15	100		30	30
		10	7.7	20	100		20	20
		10	7.7	26	80		10	10
3	Nov. 21	5	5.6	26	100			
		5	5.5	35	100			
		5	5.6	45	60			
		5	1.9	95	40			

* Time in hours after the organisms were fed to the fish.

CONCLUSIONS

A difference does exist in the rate of digestion of different kinds of organisms, and must, therefore, be taken into consideration in evaluating stomach contents of fishes. The following method is suggested:

Using a constant temperature and hourly samples of twenty fish each, let the relative values given to each kind of organism be the reciprocal of the time in hours required for 50 per cent [1] of the stomachs to become emptied of that organism. The ratio of these values multiplied by the actual number of organisms found in the stomach of the fish will give the relative numbers eaten.

Thus, as roughly indicated by the experiment, if 50 per cent of the caddis fly larvae are passed through the stomach in twenty hours and 50 per cent of the stonefly larvae are passed through in sixty hours, their respective values for stomach analysis are 3 and 1 (the ratio of 1/20 to 1/60). Then if we find upon examining a large number of brook trout stomachs that three times as many stoneflies as caddis flies are present, it does not mean that three times as many stoneflies were eaten, but rather that the two organisms were eaten in equal numbers.

A soft-bodied, easily digested form, such as *Chaoborus*, might be taken as a standard type and the rate for all other forms measured in comparison with this standard type. The standardized values thus obtained might be termed "evaluation factors." These factors would be expected to vary with different species of fish, though they might be similar for closely related species.

Once these evaluation factors have been accurately determined for a given species of fish, they should be available for permanent use. One evaluation factor would probably apply to an entire group of similar organisms, such as all stoneflies of the family Perlidae. Such factors as age of fish, amount of food eaten, and temperature, though they affect the actual rate

[1] The 50 per cent point is chosen to eliminate the extremes at each end.

of digestion, should not affect the ratio of the rates for the different organisms. This should be tested experimentally.

It is acknowledged that the data submitted above only indicate that a difference in the rate of digestion of different kinds of organisms does occur; and they are not sufficient for the actual determination of evaluation factors. The latter should be determined with larger samples according to the method outlined above.

Thanks are due to Professor G. C. Embody for making available the facilities for carrying out this experiment, and to A. V. Tunison for furnishing the fish which were used.

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Observations on the Life History of the Spotted Darter, *Poecilichthys maculatus* (Kirtland)

By Edward C. Raney and Ernest A. Lachner

Of interest to students of percid fishes is the discovery that another of our darters, *Poecilichthys maculatus,* deposits its eggs under stones, and that the male remains to guard them. However, *P. maculatus* is unique among those darters whose breeding habits are known in that the eggs are laid in a wedge shaped mass (fig. 1) rather than in a single layer.

Seal (1892: 9) and Adams and Hankinson (1928: 461) have described the spawning habits and eggs of the eastern johnny darter, *Boleosoma nigrum olmstedi.* Hankinson (1932: 422) has reported on the spawning habits of the western johnny darter, *Boleosoma nigrum nigrum.* Greeley (1927: 65) and Lake (1936) have published accounts of the breeding habits of the fan-tailed darter, *Catonotus flabellaris flabellaris.* Both sub-species of the johnny darter and the fan-tailed darter lay their eggs in a single layer on the under sides of stones. Occasionally, however, especially in the johnny darter, other flat objects such as a piece of tin or a mussel shell may be utilized. In both species the male remains with the eggs. Reeves (1907) has reported on the breeding habits of the rainbow darter, *Poecilichthys caeruleus,* and Jaffa (1917) has published on the spawning habits of the Iowa darter, *Poecilichthys exilis.* Habits of various other darters have been noted by Hankinson (1932), Jordan and Copeland (1876), J. J. Petravicz (1936), W. P. Petravicz (1938) and Reighard (1913).

Range and Habitat

The known range of the spotted darter extends from the upper Ohio drainage basin in Ohio, New York and Pennsylvania southward, west of the Appalachian Mountains, through Kentucky, Tennessee and Virginia[1] to northern Alabama. In western Pennsylvania, where the following observations have been made, this species is a typical river darter, having been taken in the Shenango River, Allegheny River and French Creek. In these streams it is limited to the faster, deeper parts of riffles which have a plentiful supply of gravel and rubble. Although it has been formerly thought of as a rare species it has likely been overlooked by many collectors who have not worked the deeper riffles thoroughly. We have taken it in all months of the year and it moves but slightly to deeper parts of the same riffle during the winter months.

In various riffles on the Shenango River near Delaware Grove where observations have been carried on over a period of four years, we have noted a tendency for *P. maculatus* to remain somewhat isolated from the other darters, such as *Boleosoma nigrum nigrum, Poecilichthys variatus, P. zonalis zonalis, P. caeruleus, Catonotus flabellaris flabellaris,* and *Etheostoma blennioides blennioides,* which are most often found in the same habitat. These darters are usually present in the same riffle during the winter as well as in the summer. Two catfishes, *Noturus flavus* and *Schilbeodes eleutherus,* are often associated with *P. maculatus* during the summer but retire to the deeper pools during the winter. Several minnows, such as *Nocomis micropogon, Notropis rubellus* and *Campostoma anomalum anomalum,* as well as the hog sucker, *Hypentelium nigricans,* are also common summer associates.

Sexual Dimorphism

Sexual dimorphism is marked both in breeding and non-breeding specimens. The males take on brighter hues with the approach of the spawning season but the females remain about the same color throughout the year. An outstanding feature in the breeding males in June is that the dorsal fins have a white edging which appears as a white line along the middle of the back and continues around the caudal fin. It is continued forward on the mid-dorsal region of the head and is either white or blue-green. This feature enables one to identify the males at once even in fairly deep, fast water, and may also be noted in freshly preserved specimens. In males taken October 1, there was only a slight edging of white on the dorsal and caudal fins and the top of the head was dark brown. In males taken February 2, breeding color was being assumed; the white band running from the snout along the top of the head and posteriorly around the caudal fin was well developed. The females have the top of the head dark and lack the marked white edging on the olive colored dorsal fin at all times.

The males at all seasons have circular red spots, each edged with black, scattered irregularly over the sides of the body. Sprinkled over the sides of the females are dark spots which are larger and more diffuse than the red spots of the male. The cheeks are blue-green in the breeding male but are light brown in males taken on October 1. The cheeks of the female are al-

[1] Specimens from Virginia, taken recently by Dr. Carl L. Hubbs, are in the collection of the Museum of Zoology, University of Michigan.

ways brown. The isthmus and breast of the breeding male are blue-green whereas in the non-breeding male and in the female they are light brown.

The dorsal, caudal and anal fins are unspotted in the male. In the females the dorsal, caudal and, to a lesser extent, the anal fins are light olive with many dark spots. Males taken on October 1, have a slight amount of orange-red in the dorsal and caudal fins. In breeding males these fins are dusky. The ventral and anal fins of the breeding male are blue-green with velvet white edgings. In the females these fins are either clear or dusky with a tendency for a white edging.

Some specimens of both sexes have dark vertical bars on the sides while all adults have faint dark horizontal streaks along the scale rows. These streaks become more pronounced posteriorly.

The males attain a larger size than females. Among 452 adults taken at various localities at different times of the year, the longest male is 68 mm. in standard length, and the largest female, 58 mm.

Spawning Site and Associates

The following observations were made in French Creek at Mill Village, Erie County, Pennsylvania, on June 7, 1938. Since conditions here were much the same as in the other localities along French Creek and the Shenango River where eggs were taken, we shall go into some detail in our description of this nesting site.

The first incidental clue to the eggs came during the scuffing of stones in the swifter part of the riffle. Dislodged eggs floated in small groups into the net. Many adults of *Poecilichthys maculatus* as well as a number of other darters were taken in the same haul. By lifting each stone of the riffle a careful search disclosed six sets of eggs. Each set was guarded by a highly colored male of *P. maculatus*. The bottom consisted of a mixture of sand, gravel and rubble. The spawning sites, with the exception of the one mentioned above, which was located in the faster central part of the riffle, were localized in a more quiet area about 10 feet wide at the head of the riffle, just before and after the water broke in its descent over the riffle. The stream at this point was 100 feet wide and the riffle was about 150 feet long. A few egg masses were taken within 10 feet of shore. The water over the eggs varied in depth from 6 inches to 2 feet. Although the water on the riffle was clear enough for the eggs to have been seen easily, none were taken at greater depths. The flat stones under which the eggs were attached varied from 3 to 9 inches in diameter and although a number of large stones were available in the nesting zone, none were chosen. No vegetation was present at Mill Village on June 7 and only a slight amount of filamentous algae was noted on June 17. In French Creek, at Carlton, a considerable amount of a dwarfish spermatophyte covered practically all stones.

The minimum distance between nests was 4 feet, even though satisfactory sites were available within that distance. The scattered nature of the nests perhaps indicates that each male guards a certain territory. With the fan-tailed darter, *Catonotus flabellaris flabellaris* and the eastern johnny darter, *Boleosoma nigrum olmstedi*, there is usually but one male to a stone. However, as many as three males of *Boleosoma nigrum olmstedi* at times have

holdings under one large stone. An instance of this nature was noted on May 29, 1938, in a sandy bay off Lake Ontario, Fair Haven State Park, Oswego County, New York. There were three males, and perhaps a fourth, with holdings under one large flat rock on sandy bottom. In this locality satisfactory breeding situations were unusually scarce. As far as is known there is but one male to a stone and set of eggs for the western johnny darter, *Boleosoma nigrum nigrum*, the subspecies which occurs in western Pennsylvania. In nesting, both *Catonotus flabellaris flabellaris* and *Boleosoma nigrum nigrum* usually choose more quiet water than *P. maculatus*.

Although the stone catfish, *Noturus flavus*, was present at all localities where *P. maculatus* eggs were found and is known to lay its yellow mass of eggs under stones in the same general habitat which is occupied by *P. maculatus*, no nests were found, at least through June 17, 1938. However, the stone catfish chooses larger stones than the spotted darter.

No other darters were seen spawning at Mill Village, although ripe females of the blue-breasted darter, *Poecilichthys camurus*, were taken on June 7, 1938, in the same seine hauls with *P. maculatus*. Apparently *P. variatus* and *P. zonalis zonalis* had finished spawning at this time. Several feet above the riffle a large number of the rosy shiner, *Notropis rubellus*, were seen spawning over the nest of a river chub, *Nocomis micropogon*, as they commonly do especially in the larger streams of western Pennsylvania. The utilization of the nests of *Nocomis* by other fishes has been observed in the Saline River, Michigan, by Hankinson (1932: 415).

Among the fishes which were taken in the same riffle with *P. maculatus* at Mill Village were: *Hypentelium nigricans, Nocomis micropogon, Notropis volucellus volucellus, N. rubellus, N. cornutus chrysocephalus, Hyborhynchus notatus, Campostoma anomalum anomalum, Noturus flavus, Schilbeodes eleutherus, Poecilichthys variatus, P. camurus, P. zonalis zonalis, P. caeruleus, Catonotus flabellaris flabellaris, Etheostoma blennioides blennioides*. The hellbender, *Cryptobranchus alleganiensis*, was also present. The above species with a few additions were associates of *Poecilichthys maculatus* in the other localities where eggs were taken. At both Venango and Carlton on French Creek, *Boleosoma nigrum nigrum* and *Poecilichthys tippecanoe* were also found in the same habitat with nesting males of *P. maculatus*.

Time of Spawning

The breeding season extends from the last week in May through the last week in June. Part of a set of eggs, which appeared to have been freshly laid, was collected on May 30, 1935, in French Creek at Wattsburg, Erie County; and on the same day a set of eggs apparently about ready to hatch was taken in French Creek at Carlton, Mercer County. On June 7, 1938, in French Creek at Mill Village, six batches of eggs were taken. The temperature of the air was 19° C., of the water 17.8° C. Part of the eggs in each set were eyed at this time. This was also true of all those sets collected later in the month. Two sets were taken in the Shenango River near Delaware Grove, Mercer County, on June 9, 1938. On June 17, 1938, eight egg clusters were noted at Mill Village, one set in French Creek at Carlton, Mercer County, and two sets in French Creek at Venango, Crawford County.

Eggs

The large adhesive, demersal eggs were laid in masses under stones (fig. 1), which with few exceptions rested upon other stones as a base. The eggs were then packed in tightly so that each egg mass was wedge-shaped, being from one to four egg layers thick on one side and five to ten layers thick on the other. The open side of the nesting site faced up stream so that the current washed into the cavity under the stone. The eggs were wedged between the stones so tightly that in all masses those toward the downstream side and some in the middle were dead. From one-half to one-quarter of the eggs were dead, presumably because of poor aeration due to their position.

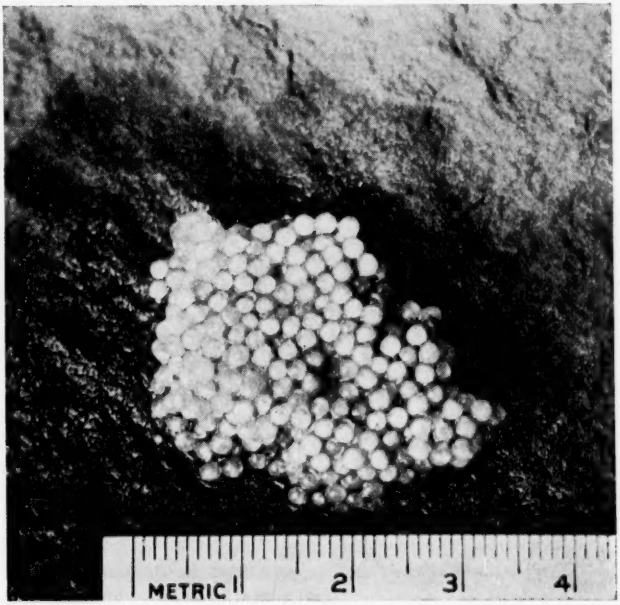

Fig. 1. Set of eggs of the spotted darter found in French Creek at Mill Village, Erie County, Pennsylvania, on June 7, 1938.

The eggs are light yellow in color with a well defined golden oil droplet. They are very adhesive and are 2 mm. in diameter (in formalin). When viewed as a whole, the egg mass is yellow. The masses vary somewhat in size and shape when viewed from above; most of them are approximately rectangular. The largest observed was roughly rectangular in shape with dimensions of 2 by 3.5 cm. (fig. 1). Several of the smallest, which perhaps had not received their full complement of eggs, were roughly circular and 1.5 cm. in diameter. Four of the larger masses contained respectively 288, 310, 321, and 352 eggs. Smaller masses (approximately 140 to 180 eggs) are doubtless incomplete sets and ripe females were always in their neighborhood.

Not all of the eggs in a set are laid at one time. In all groups of eggs collected on June 7 or later, some of the eggs were eyed while others appeared to have been freshly laid. An examination of the ovaries of a number of adult females which were found near the nests and which were considerably swollen externally showed that they do not mature all their eggs at once. Of ten females, eight had from 47 to 76, with an average of 65, well developed eggs scattered through their ovaries, and the remaining eggs were much smaller. It appeared that a considerable number of the remaining eggs would mature later and be laid in the same spawning season. Two of the ten females were ripe, with 62 and 83 eggs massed just inside the external genital opening ready to be laid. It would appear from the limited evidence at hand that each female lays from two to four times during a single spawning season of approximately five weeks in length.

The ovaries of large March females, averaging 50 mm. in standard length, contained on the average 400 eggs. Smaller females had fewer eggs, the average number being approximately half as many in females from 40 to 45 mm. in length.

Care of Eggs

Our observations indicate that only the male stays with the eggs. Normally facing upstream, he would be either crowded close to the stone or under it with only his head or tail protruding. When we overturned the stone the male would remain near the eggs, still, or moving slowly about in the area. Several males were captured by grasping them with the hands. Numerous females as well as other males without holdings could be observed in the neighborhood of the nest. Never did we note any fish attempting to eat the eggs, either when the protecting stone was removed or when in its normal position.

Males with holdings and ripe or near ripe females taken in June, were found to have eaten, food being found in each of the twenty-five adults examined. Three of the fourteen males examined had eggs of *P. maculatus* in their stomachs. One male had eaten 17 eggs, several of which were eyed. Although no males were seen eating eggs it appears likely that they do eat the eggs which they are guarding. It is possible of course that the eggs found had been those watched over by other males, and it is unlikely that they were waste eggs which had been washed out of the nest. Two out of the eleven females examined had eaten *P. maculatus* eggs.

Food

No thorough analysis of the food was made, but of the twenty-five specimens taken in June, aquatic insect larvae made up 95 per cent of the diet. The bulk of the food consisted of the larvae of Diptera, largely chironomids, and caddis larvae (Trichoptera). Larvae of stone flies (Plecoptera), mayflies (Ephemerida) and beetles (Coleoptera) occurred frequently enough to be important items. Of the non-insect food, water-mites (Hydracarina) were found in most of the stomachs.

Young

No information was obtained on the length of the incubation period. Newly hatched larvae were only observed in the aquarium. They were

from eyed eggs obtained on June 7, 1938, and hatched overnight. Hatching appeared to be aided considerably by violent motions of the young within the tough egg membrane. Immediately after hatching each larva settled to the bottom of the jar and there remained, lying on its side. Occasional erratic movements were produced by rigorous jerking of the bodies and it appeared to require considerable effort for them to reach the surface of the water 2 inches away. After two days, all of the young died and at this time most of them were covered with water mold which had developed in the jars.

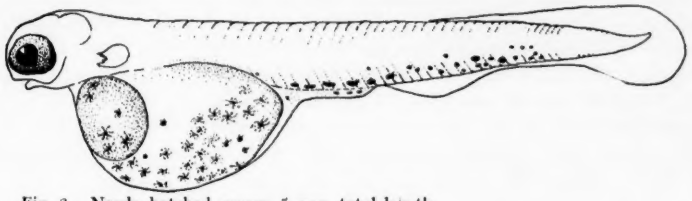

Fig. 2. Newly hatched young, 5 mm. total length.

The newly hatched larvae have an oval yolk sac with the prominent oil droplet anterior in position as is portrayed in figure 2. They vary from 5 to 6 mm. in total length. The mouth is open in the fry as it comes out of the egg.

Forty-eight hours after hatching, the larvae average 8 mm. in total length. The yolk sac with the enclosed oil droplet is still present although reduced considerably in size. A few more melanophores are present on the posterior part of the abdomen than appeared in the newly hatched fry. The chromatophores on the underside of the yolk sac are characteristically arranged in continuous S-shaped curves.

The average standard length of fourteen young taken at Carlton August 26, was 23.2 mm. with a range of 21 to 28 mm. The average length of twenty-six taken on October 1 at Mill Village was 25 mm. with a range of 22 to 28 mm. An average length of 32 mm. with a range of 27 to 36 mm. was obtained in twenty-nine young of the previous year taken on March 16 in the Shenango River near Delaware Grove.

Young of the year taken October 1, were olive in color with diffuse dark spots scattered over the body. The dorsal and caudal fins were yellow brown and tended to be spotted as in the adult female. The pectoral, ventral and anal fins were clear, with a slight suggestion of milky white toward the edge and in some with a small amount of black toward the base.

Sex Ratio, Growth and Age at Maturity

In all but a very few collections the males have outnumbered the females. Of a total of 452 adults taken throughout the year at various localities, 289 were males and 163 were females. Lake (1936: 828) has reported for *Catonotus f. flabellaris* "that the females outnumbered the males in the proportion of 520 to 228." In collections taken on the spawning grounds at Mill Village on June 7 and June 17, there were thirty-seven males and fourteen females. Collections made in the Shenango River near Delaware

Grove in March, April and early May contained seventy-five males and fifty-three females. In one large collection taken March 16 at the same place there were twenty-two males and twenty-two females. This was the only large collection in which the number of females equaled or approached the number of males. In a large collection taken in French Creek at Venango on August 24, there were thirty-nine males and only three females. In the few series in which the females outnumbered the males only a small number of specimens were obtained and the figures are probably not significant.

A study of the length-frequency distribution of thirty-three yearlings, seventy-one males and fifty-two females taken during March and April from one riffle of the Shenango River, makes it possible to determine the average growth attained at least during the first two years. Although these numbers might at first glance be considered too small to be significant, they are probably representative of the population of the spotted darter in one large riffle. We were not able to read the scales of any of the specimens and thus cannot make definite statements concerning the maximum age reached by males and females.

The young, now almost a year old, averaged 32 mm. in standard length. None of these yearlings was sexually mature. In the fan-tailed darter, *Catonotus f. flabellaris,* according to Lake (1936: 828), "it seems apparent that female fan-tailed darters reach sexual maturity and spawn during the spring of the year following that of hatching and again the year after." The female spotted darters reach an approximate average standard length of 44 mm. at an age of two years, and spawn. They undoubtedly spawn again at three years at an approximate length of 50 mm. Some few of the larger females may reach an age of four or five years and spawn again. The largest female examined was 58 mm.

The males grow faster than the females and reach an average standard length of 48 mm. in two years. They apparently spawn at this age as well as at the end of their third and perhaps fourth years. A few of the larger specimens guarding nests might very well be five years old. The largest male examined was 68 mm. long. Of the seventy-one males, thirty, or 42 per cent, attained a greater length than that of the largest female.

We wish to acknowledge the assistance of several individuals who have aided us in this study. Mr. Kellar Shelar, State Teachers College, Slippery Rock, Pennsylvania, has been an inspiring companion in the field over a period of years. Dr. A. H. Wright, Cornell University, and Dr. Carl L. Hubbs, University of Michigan, read the manuscript and have given a number of valuable suggestions. The drawing of the newly hatched larva (fig. 2) was made by Mr. Dwight A. Webster, Cornell University.

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The Spawning Behaviour of *Fundulus diaphanus* (Le Sueur)

By LAURENCE R. RICHARDSON

THE present account of the breeding behaviour of *Fundulus diaphanus diaphanus* (Le Sueur) is based on field observations and on the mating and spawning of three pairs of this species taken during the last week of May, 1935, from a small brook near Iberville, Quebec, a tributary of the Richelieu River.

On several occasions during the previous summer I had visited this brook, a small lowland stream little more than a trickle during the warm months but containing several large pools. I found *Fundulus* present for the first time in the spring of 1935 shortly after the ice had left the brook. Asso-

ciated with the *Fundulus* at this time were *Hyborhynchus notatus, Notemigonus chrysoleucas, Notropis cornutus* and *Semotilus atromaculatus*. Towards the latter end of May, the stream temperature had risen to 21.0° C and was holding quite steady at this point. With the exception of the *Notemigonus* the other fishes had spawned, and after several days at this temperature the *Fundulus* commenced to show signs of pairing and of other activities preparatory to spawning.

The male *Fundulus* scattered out in the pools and selected breeding areas which they defended against intruders of their own and of other species. Combat between males was common but it was not especially vicious nor did it result in evident damage to the fighters. The courting behaviour described below was observed on several occasions, but did not result in spawning.

Late in the week, I collected three pairs of gravid fish and transferred them to set aquaria heavily planted with *Valisneria* and *Cabomba*. The tanks were then being kept at a temperature of 23.0° C, and the sharp rise in temperature induced almost immediate mating activities. During transportation the intensity of coloration of both sexes had decreased markedly, and on arrival at the aquaria the males had become quite colorless. In the tanks, the male coloration strengthened, and shortly before mating took place, increased suddenly to a maximum intensity, with the vertical bars broad and very deep in color, strong black markings on the fins and a background of a brilliant bluish-green. The female was noticeably paler even at this time.

Within an hour of placing the fish in the tanks, combat between the males had commenced, leading finally to the fish pairing off according to size, each male selecting and pursuing an individual female. During the preliminary pursuit of the female, the genital papilla enlarged, protruded obviously from the body and after several minutes extruded a single egg.

The egg fell away from the female and finally came to rest an inch below the papilla, being suspended below the latter by a fine, translucent thread. At this point, the male commenced an even more vigorous pursuit, driving the female towards the mass of floating weeds, finally cornering her in a pocket of the weeds and moving alongside her, pressing her body firmly into the weeds, at the same time holding her there by locking his fins with hers. This was followed by a period of intense excitement, the entire body of the male quivering rapidly and assuming a bow-shape. Curving the convex side against the female he pressed her strongly against the weeds. Under this stimulation, the female released a cluster of eggs, in various instances five to ten eggs in the cluster, which became suspended below the female by a thread as was the single egg, and the individual eggs in the cluster were each attached to this thread by a short thread.

Fertilization had taken place during the above performance, and as the fertilization membrane rose, the eggs generally separated from the cluster and became detached from the thread. In falling, most of the eggs became entangled in the weeds, caught up and held there by their individual threads which appear to be quite adhesive. On several occasions the cluster failed to break up, and the female, having been released by the male, moved away with the eggs still suspended below her until the thread caught on a weed, when the thread would break away from the papilla.

The above processes were repeated several times for each pair of fish over a period of five minutes. As one cluster of eggs was released, the male would permit the female to move away, then follow her and repeat the performance in another portion of the tank. Each operation lasted from a quarter to a half of a minute, and in all about fifty eggs were deposited by each pair. Unfortunately none of the eggs survived to hatching. Development to the eyed stage took place in three days, but from then on the eggs began to die, and all were dead six days after spawning. The parent fish were kept in the tanks during the development of the eggs, but showed no further interest in them and did not attempt to eat them.

The spawning of this species has been very briefly described by Greeley (1934), his observations on combat, courting and spawning agreeing with the present account; but he does not mention the presence of adhesive threads suspending the eggs from the females, a thing not easy to observe in the field.

The pugnacious behaviour of the males, the courting display of colors and the mating and spawning procedure are common amongst the egg-laying cyprinodonts, but so far as I am aware the suspension of eggs in clusters from the papilla of the female by a thread is paralleled only in the Cuban egg-laying cyprinodont *Cubanichthys cubensis* (Eigenmann). Little is known of the spawning of the latter species but amongst aquarists who have handled it, there is an inclination to believe that it may be its habit, under natural conditions, for the female to carry the eggs in a cluster suspended below the body until they have hatched. I very much doubt that this can be true, since in *Fundulus* the thread suspending the cluster, while seemingly strong, always broke or became detached when it came in contact with a plant. A thread such as described for *Fundulus diaphanus* and for *Cubanichthys* is not found in other egg-laying cyprinodonts of known habits. In the latter the eggs are adhesive and lack special attachment devices, generally being freely scattered in dense clumps of weeds.

A technique intermediate between that of the majority of egg-laying cyprinodonts and that of *Fundulus diaphanus* appears in the medaka, *Oryzias latipes* (Schlegel). In the spawning of this oriental cyprinodont the eggs are not suspended below the female, but when extruded remain attached to the vent, to the abdomen in the vicinity of the vent and even to the anal fin, there to remain until wiped off as the female swims through weeds. This method of spawning may be considered more primitive than that of *F. diaphanus* and *C. cubensis*, and one may readily see the probable path in evolution of the egg-suspension technique, which is particularly interesting, for it has not involved marked change in morphology or spawning behaviour.

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Ichthyological Notes

HEPSETUS TO REPLACE *HYDROCYONOIDES* AND *SARCODACES* FOR A GENUS OF AFRICAN FRESH-WATER FISHES.—It appears to have been generally overlooked that William Swainson proposed a generic name for the pike-like African characin commonly known as *Sarcodaces*. In Volume I of his book, *On the Natural History and Classification of Fishes, Amphibians, and Reptiles* (1838), this author after describing and figuring the very similar South American fish *Xiphostoma* wrote (259–60):

> In the sub-genus *Hepsetus* Sw., which includes the African or Old World representatives of the American Xiphostomi, the jaws, although narrow and rather attenuate at their tips, when viewed laterally, are nevertheless considerably wider above; but they are not lengthened; both are equal, and armed with sharp slender teeth of unequal sizes. In these fishes, the first dorsal is still further removed from the head than in *Xiphostoma*, and the upper jaw is more angulated: the appearance of all these fish reminds us so much of pikes, that they may be termed pike-salmon: but few species are known, and they all appear to inhabit the tropics of the Old World.

Clearly this characterization fits only one species, currently named *Sarcodaces odoë* (Bloch). *Salmo odoë* must therefore be regarded as the logotype of *Hepsetus*, and is hereby so designated. The species should be known as *Hepsetus odoë* (Bloch).

Hepsetus is antedated but according to current rules not preoccupied by *Hepsetia* Bonaparte.

Another name indubitably pertaining to the same genus antedates *Sarcodaces*. Boulenger in the *Catalogue of the Fresh-water Fishes of Africa* (1, 1909: 177) and Jordan in *The Genera of Fishes* (Part 3, 1909: 301 and 333), regarded *Hydrocyonoides* Castelnau (1861) as a synonym of *Sarcodaces* Günther (1864), yet accepted the more recent name. *Hydrocyonoides* as well as *Sarcodaces* will stand as a synonym of *Hepsetus*.

The name of the subfamily Sarcodacinae, recognized by Eigenmann (1910) and by Regan (1911) will of course need to be replaced by **Hepsetinae** (new subfamily name). CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

OCCURRENCE OF THE CYPRINODONT FISH *FUNDULUS PARVIPINNIS* IN FRESH WATER IN SAN JUAN CREEK, SOUTHERN CALIFORNIA.—San Juan Creek is the principal stream draining the region of the Elsinore Mountains in Orange County, California. It crosses the coastal plain approximately half way between Los Angeles and San Diego, and is joined about one-half mile south of San Juan Capistrano by the Arroyo Trabuco; the latter rises on the southern slopes of the Santa Ana Mountains. On December 26, 1938, while seining these heretofore uninvestigated waters, the Pacific killifish, *Fundulus parvipinnis*, was taken in strictly fresh water about one mile from the ocean. This euryhaline species is known to inhabit marine and brackish waters, but, as Dr. George S. Myers tells me, it is very unusual to find it invading fresh water to the extent which was observed here. In this regard, Keys (1931, Bull. Scripps Inst. Oceanog., Tech. Ser. 2: 420), in his article "A Study of the Selective Action of Decreased Salinity and of Asphyxiation on the Pacific Killifish, *Fundulus parvipinnis*" says: "As far as I have been able to discover, *Fundulus parvipinnis* is never found in fresh water, nor does it exist in salt or brackish water having permanent communication with fresh water. . . ." Only by subsequent collections can it be determined whether this species inhabits the fresh water of this stream. Keys has shown that under laboratory conditions this fish can live in fresh water once it has become acclimated to it. It is possible that as the salinity decreased in the landlocked slough at the mouth of San Juan Creek, due to heavy floods which ended less than a week previously, the fish became acclimated and migrated upstream. It may be of interest to note that many of our desert-spring cyprinodonts (genus *Cyprinodon*) can readily live in either fresh or sea water. The associated fish fauna in San Juan Creek included the goby, *Eucyclogobius newberryi* (Ginsburg, *in litt.*), the stickleback, *Gasterosteus aculeatus williamsoni*, and the minnow, *Gila orcutti*. The goby is also a euryhaline species. Farther upstream, in the Arroyo Trabuco, a single specimen of the rainbow trout, *Salmo gairdneri irrdeus*, was taken; the minnow and stickleback were also found here. The collection was made in a section of these streams extending from about a quarter of a mile north of San Juan Capistrano to the ocean.—ROBERT R. MILLER, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

A LAMPREY OF THE GENUS *LAMPETRA* FROM INDIANA.—Lampreys currently referred to the genus *Lampetra* occur in eastern United States, as was shown by Creaser and Hubbs (1922, A revision of the Holarctic lampreys. *Occ. Papers Mus. Zool., Univ. Mich.*, 120: 1–4, Pl. 1). They described the range of the single recognized species as "Ohio and Potomac River basins" and designated it as *Lampetra lamottenii* Le Sueur.

Studies on later collections of this lamprey by Hubbs and Trautman, p. 23 (1937, A revision of the lamprey genus *Ichthyomyzon. Misc. Publ. Mus. Zool. Univ. Mich.*, 35: 1–110, Pls. 1–2) have shown the range to be "*Lampetra* is known only from the upper Ohio Valley, where it is common, and from one locality (Laurel Run) in eastern Maryland; in Ohio it is even confined to the Appalachian foothills."

The hitherto lost original description of *"Petromyzon Lamottenii"* of Le Sueur, pp. 6–10, pl. 6 (1827, American ichthyology, or natural history of the fishes of North America: with colored figures from drawings executed from nature. New-Harmony, Indiana: 44 pp. (unnumbered), 9 pls.) has been republished by Hubbs and Trautman (1937: 23). They show that for "a variety of reasons" it now seems extremely probable that Le Sueur's *"Petromyzon Lamottenii"* was based on a species of *Entosphenus*, and that the type locality was "near 'the Lamotte Mine in Missouri,' now Mine Lamotte, Jackson County, Missouri, in the St. Francis River system. Gray (1851*a*: 238 and 1851*b*: 142) erred in attributing *Lampetra Lamottenii* to New York" (Hubbs and Trautman, 1937: p. 23–24). Incidentally, Mine Lamotte, Missouri, is in *Madison* County not *Jackson* County. Since lampreys of the genus *Entosphenus* are known "through the west" and the range of the lampreys of the genus *Lampetra* is restricted as quoted above, they conclude "consequently *Entosphenus appendix* (DeKay) becomes *E. lamottenii* (Le Sueur) and *Lampetra lamottenii* (Le Sueur) becomes *L. aepyptera* (Abbott)."

It is therefore of much interest in view of the previous known range of *L. aepyptera* to note that lampreys of the genus *Lampetra* occur as far west as Indiana in Lick Creek, Orange County, near West Baden, Indiana. Walter Petravicz has presented the author with an adult male specimen which he collected in early April, 1937, and kept alive for some weeks in an aquarium. Lick Creek is a branch of the Wabash River in southern Indiana.

While on other grounds given by Hubbs and Trautman it still seems probable that *Petromyzon lamottenii* was not based on this species, it is of interest to note that *Lampetra aepyptera* occurs within 175 miles at least of the type locality. This is an addition to the vertebrate fauna of Indiana.—CHARLES W. CREASER, *Wayne University, Detroit, Michigan.*

Herpetological Notes

ANOLIS CAROLINENSIS IN TENNESSEE.—A note by Doris M. Cochran (1938, COPEIA, 2:90) reports *Anolis carolinensis* from the Great Smoky Mountains as a record apparently new to Tennessee. Jones and Ressler (1927, COPEIA, 164:87) reported this lizard from Hamilton, Blount and Sevier counties, Tennessee. Miss Cochran's note adds two additional county records, but doesn't add to the lizard fauna of Tennessee. When the writer visited Pickwick Dam, Hardin County, Tennessee, on April 19, 1938, one of the boys in the local school offered him four live specimens of *Anolis carolinensis* which he had recently caught in the immediate vicinity of the dam. Two of the specimens were accepted and are now in the Tennessee Valley Authority collection at Norris. This adds another locality to the known range of the species in this state.—A. R. CAHN, *Norris, Tennessee.*

AN ANOMALOUS PREGNANCY IN THE COPPERHEAD—A female highland moccasin or copperhead (*Agkistrodon mokasen*) collected at Abbeville, Mississippi, was brought into the University of Mississippi WPA Plant and Animal Survey Laboratory on July 12, 1938, by Mr. Earl Wimberly. The snake was set aside in a glass jar until July 16, when it was killed preparatory to examination for internal parasites. It measured 680 mm. in total length, with a tail length of 87 mm.

On opening the specimen it was found to contain five living embryos attached to and developing within the oviduct. These were normal in every respect, and had developed all the facial features and some of the internal organs, resembling chick embryos after about 72 hours of incubation. Four embryos removed from the egg membranes averaged 59.5 mm. in total length. The right ovary contained a dozen or more small immature eggs, the largest of which was about 3 mm. in long diameter, but the right oviduct contained no developing eggs.

At the anterior end of the left oviduct, adjacent to the embryos, was an egg that had become non-viable and hardened, consisting wholly of yolk. It measured 35 mm. in long diameter and 20 mm. in transverse diameter, and was ovate in form. The viable eggs, in contrast, were soft and almost spherical, with an average diameter of approximately 25 mm.

Further examination revealed a fully developed young copperhead lying tightly coiled in S-form just caudad of the most posterior viable egg. This snake was dead and about half of it was in a kind of mummified state. It was surrounded by the usual egg membranes. It measured 180 mm. in total length and had been greatly distorted, especially in the head region. The snake was attached to the intestinal mesentery, and had apparently developed ectopically within the body cavity of the mother; it was not connected to the oviduct in any way. It seems likely that this embryo was carried over from the previous year.—JOHN S. DOLLEY, *University, Mississippi.*

A SYSTEM OF MARKING TURTLES FOR FUTURE IDENTIFICATION.[1]—A system to be used in marking turtles must be permanent, since turtles have a long life span, must definitely identify each individual, must not handicap the turtle in any way, and should be simple and easy to use. The first of these requirements eliminates the use of any foreign objects such as metal tags or leg bands. The only other means of marking are scarring of the carapace or plastron, clipping of toes, or tattooing.

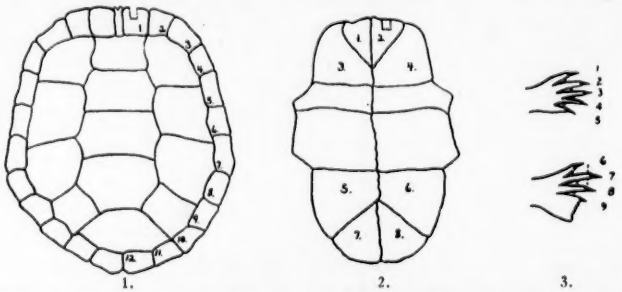


Figure 1.—Marginal plates are numbered 1 to 12 on each side. Plates 4, 5, 6, 7 can not be marked satisfactorily in most turtles. A turtle marked as shown would be recognized as 0-1. Figure 2.—Plastral plates can be marked as above. A notch in marginal plate 1 to indicate the second series of marks; a notch in plate 2 to indicate the third series, etc. Figure 3.—The feet are placed in walking position and the toes numbered 1-5 on the forefoot and 6-9 on the rear foot. Dotted line indicates portion of toe removed.

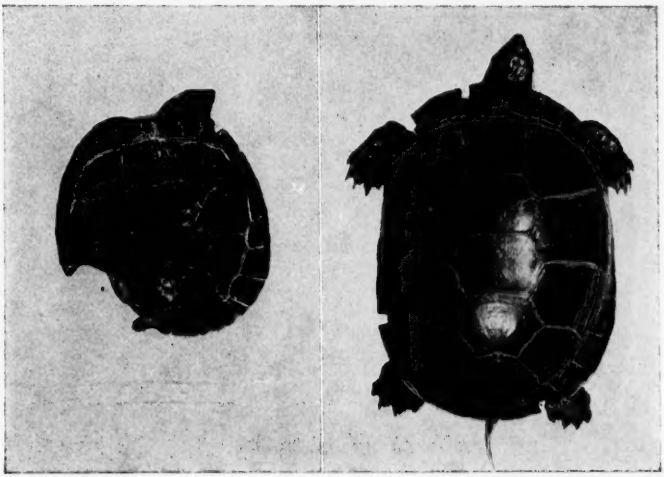
Mr. John T. Nichols of the American Museum of Natural History has been marking box turtles for twenty-four years, using a system in which figures are carved in the plates of the carapace. Mr. Nichols states in correspondence that such marks remain distinct after ten or fifteen years, but that they can not be used on turtles that molt the outer plates or on those taken in large quantities at one time.

[1] A contribution from the University of Michigan Biological Station.

The marking system making use of notches in the carapace and plastron, and of clipped toes, described below, was worked out under the direction of the late Dr. Frank N. Blanchard during the summer of 1937 at the University of Michigan Biological Station, Douglas Lake, Michigan.

Marginal plates, exclusive of those connected to the plastron, are marked by a rectangular notch, one-third to one-half the width of the plate. Such notches can be quickly made with a triangular file to make the first cut, followed by a square-edged file to widen it to the proper shape (fig. 5). This filing requires only a few minutes and does little injury to the turtle, although occasionally it may cause the wound to bleed slightly.

Small turtles whose carapace is not ossified may be marked with a small pair of sharp-pointed scissors. Care should be taken in marking turtles whose carapace is partially ossified, as the process is likely to cause serious fracture of carapacial plates, resulting in the death of the turtle or loss of a considerable portion of the carapace (fig. 4.)



4. 5.

Figure 4.—Results of attempting to mark a partially ossified carapace with scissors. This turtle was marked 8, 11-3. The marks in the plates 8 and 11 caused the adjacent costal scutes to fracture and drop away. Figure 5.—A turtle marked 1, 3, 8-11.

The marginals must be marked according to a definite system. Beginning with the anterior marginal on each side, the plates are numbered from front to back (fig. 1). Plates should always be counted from the nuchal, as many individuals have an abnormal number of marginals. All North American genera except *Amyda, Sternotherus,* and *Kinosternon* have 12 marginals on each side. *Sternotherus* and *Kinosternon* may be marked by this method, but the combinations using plate 12 must be eliminated. Experiments on marking *Amyda* by tattooing are in progress.

The marginal plates at the junction of carapace and plastron can not be marked. Thus in the genera *Clemmys, Emys, Chrysemys, Pseudemys, Chelydra, Macrochelys, Malaclemmys, Sternotherus, Kinosternon,* and *Terrapene,* marginals 4, 5, 6, and 7 can not be used. In *Graptemys* all the marginals except 5 and 6 can be used.

In recording marks, a hyphen is used to separate the left and right sides. Thus 1-2 indicates that the first marginal on the left side and the second marginal on the right

side are notched, while 8, 12-11 indicates that the eighth and the twelfth on the left side and the eleventh on the right side are notched.

The system uses first all the possible combinations with one plate.

0-1 1-0
0-2 2-0
0-3 3-0
0-8 8-0
0-9 9-0
0-10 10-0
0-11 11-0
0-12 12-0

All possible combinations using two plates.

1-1 2-1 3-1 ... 8-1 to 8-12 etc. to 12-12
1-2 2-2 3-2
1-3 2-3 3-3
1-8 2-8 3-8
1-9 2-9 3-9
1-10 2-10 3-10
1-11 2-11 3-11
1-12 2-12 3-12

1, 2 -0 2, 3 -0 3, 8 -0 ... 8, 9-0 to 8, 12-0 etc. to 11, 12-0
1, 3 -0 2, 8 -0 3, 9 -0
1, 8 -0 2, 9 -0 3, 10-0
1, 9 -0 2, 10-0 3, 11-0
1, 10-0 2, 11-0 3, 12-0
1, 11-0 2, 12-0
1, 12-0

Reverse last half of this series. Thus 1, 2-0 will become 0-1, 2; 11, 12-0 will become 0-11, 12.

All possible combinations using three plates.

1, 2-1 1, 3-1 1, 8-1 ... 1, 9-1 to 1, 9-12 1, 10-1 etc. to 1, 12-12
1, 2-2 1, 3-2 1, 8-2
1, 2-3 1, 3-3 1, 8-3
1, 2-8 1, 3-8 1, 8-8
1, 2-9 1, 3-9 1, 8-9
1, 2-10 1, 3-10 1, 8-10
1, 2-11 1, 3-11 1, 8-11
1, 2-12 1, 3-12 1, 8-12

1, 2, 3 -0 1, 3, 8 -0 1, 8, 9 -0 ... 1, 9, 10-0 to 1, 11, 12-0 | 2, 3, 8-0 to 2, 3, 12-0 | 2, 9, 10-0 to 2, 11, 12-0
1, 2, 8 -0 1, 3, 9 -0 1, 8, 10-0
1, 2, 9 -0 1, 3, 10-0 1, 8, 11-0
1, 2, 10-0 1, 3, 11-0 1, 8, 12-0
1, 2, 11-0 1, 3, 12-0
1, 2, 12-0

2, 8, 9-0 to 2, 8, 12-0

Reverse series.

All possible combinations using four plates.

1, 2, 3-1 1, 2, 8-1 to 1, 2, 8-12 etc. to 1, 11, 12-12 ... 1, 2, 8, 9-0 to 1, 2, 9, 12-0 | 1, 3, 8, 9-0 to 2, 3, 8, 12-0 | 2, 3, 9, 10-0 to 2, 3, 11, 12-0 | 3, 8, 9, 10-0 etc. to 9, 10, 11, 12-0
1, 2, 3-2 1, 2, 3, 8-0 1, 2, 8, 10-0 1, 3, 8, 10-0
1, 2, 3-3 1, 2, 3, 9-0 1, 2, 8, 11-0 1, 3, 8, 11-0
1, 2, 3-8 1, 2, 3, 10-0 1, 2, 8, 12-0 1, 3, 8, 12-0
1, 2, 3-9 1, 2, 3, 11-0
1, 2, 3-10 1, 2, 3, 12-0 1, 2, 9, 10-0
1, 2, 3-11 1, 2, 9, 11-0
1, 2, 3-12 1, 2, 9, 12-0

Reverse series.

This procedure provides 16 numbers using one notch; 120 using two; 560 using three; 1820 using four; a total of 2516 marks. If more are needed, the series may be repeated with a notch on one of the plastral scutes (fig. 2).

It is believed that these marks will last for several years except in young specimens. Hildebrand and Hatsel (1926, Bur. Fish. Econ. Circ. 60) state that such notches are permanent if made when the shell is well ossified, but that the marks tend to become obliterated in juvenile specimens.

In order to insure identification of juvenile specimens, they may be given a toe mark in addition to the mark on the carapace. The first phalanx of the toe is completely

removed by a snip of the scissors. Such cuts cause little pain and specimens marked show rapid healing and practically no regeneration.

With the feet in walking position, the toes are numbered 1-5 on the front foot and 6-9 on the hind foot (last toe is often unsuitable for clipping) (fig. 3). A system similar to that for the carapace marks is used. Thus 1-0 indicates that only the first toe of the left side was clipped; 1, 2-9 indicates that the first and second on the left side and the ninth on the right side were clipped.

Turtles are frequently found with toes amputated and sections of marginal plates missing. Such accidentally marked turtles can almost always be identified as such, because they rarely fit the special combination of marks or the size of the turtle indicated in the records.

Turtles marked and released in Nigger Creek, near the University of Michigan Biological Station, in the summer of 1937, and recovered the summer of 1938 showed no indication of regeneration of toes or of bone in the marginal notches. The latter had tended to enlarge somewhat.—FRED R. CAGLE, *Museum of Natural and Social Sciences, Southern Illinois Normal University, Carbondale, Illinois.*

POSSIBLE HYBRIDIZATION BETWEEN *BUFO COGNATUS* AND *B. W. WOODHOUSII*.[1]—During the evening of March 30, 1938, while collecting mated pairs of *Bufo cognatus*, near Norman, Oklahoma, a large female of *B. w. woodhousii* was found in amplexus with a medium-sized male of *B. cognatus*. These two toads were in the midst of a lively mixed chorus of the two species in the only area in the vicinity used extensively by both species for breeding. The animals were taken to the laboratory and confined in a washboiler containing about three inches of water and left undisturbed over night. The following morning thousands of eggs were in the boiler and more were being deposited. The toads were still in amplexus, but the male left the female when disturbed.

Upon examination, some of the eggs proved to be in the four-celled stage. Many were placed in shallow glass dishes of tap or spring water and allowed to develop into tadpoles. These were fed upon algae and reared through the spring months. Three metamorphosed, beginning on May 15.

As the larvae developed, a few were studied from time to time while still alive, with a binocular microscope. Their general appearance and the details of the mouthparts conformed very closely to those of *B. w. woodhousii* described by Youngstrom and Smith (1936, Amer. Midl. Nat. 17:629-633).

I was fortunate to have tadpoles of *B. w. woodhousii* and of *B. cognatus* developing at the same time, with which to compare specimens of the supposed cross. At all stages, including the recently metamorphosed young, I could find no features characteristic of *B. cognatus*. Had I not known their origin, I should have called every specimen *B. w. woodhousii* without hesitation.

There are two possible interpretations of the above observations: (1) the two species were actually crossed, but the genes of the mother which governed the external appearance were dominant in the Mendelian sense; (2) we have a case of parthenogenesis in which the sperm initiated development but took no further part in the production of the embryo. Artificial parthenogenesis is well known in frogs; and other cases have been described among animals in which the sperm did not contribute chromatin material to the embryo.

Hybridization among toads has often been suspected but the evidence has usually been inconclusive, as is mine in this instance (see, for example, Hubbs, 1918, COPEIA, 54:40-43; Power, 1926, Proc. Zool. Soc. London: 777-778; and Myers, 1927, COPEIA, 163:50-52). When time permits, I expect to examine fixed and preserved embryos of this lot by cytological or other means, in the hope of finding evidence of their hybrid or parthenogenetic nature.

The adults (Nos. 20,179 and 20,180) have been placed in the University of Oklahoma Museum of Zoology.—ARTHUR N. BRAGG, *Zoology Department, University of Oklahoma, Norman, Oklahoma.*

[1] Contributions from the Zoological Laboratory of the University of Oklahoma, No. 196.

NOTES ON THE HERPETOLOGY OF MOUNT DESERT ISLAND, MAINE.—During July and August, 1938, while employed as a ranger-naturalist in Acadia National Park, the author had occasion to collect and observe the amphibians and reptiles of Mount Desert Island, Hancock County, Maine. Most of the species herein listed may be found in the zoological collection of the Park, at Bar Harbor. Mount Desert Island, with an area of approximately 100 square miles, is located in the Gulf of Maine about twenty miles northeast of Penobscot Bay. It is separated from the mainland by a narrow channel. The island is largely forested. It is remarkable for its mountains, the highest rising to an elevation of 1530 feet above sea level. There are many scattered lakes and small streams. Most of the species here recorded were observed in the field by the author. With these records have been included certain verbal reports of local residents, and data contributed by my fellow workers. The list of species follows:

Triturus viridescens viridescens (Rafinesque).—Immature forms occur in damp woods. Adults have only been recorded from the Tarn. Uncommon.

Ambystoma maculatum (Shaw).—Records from a Bar Harbor cellar, a gravel pit at Great Head, and beneath loose soil at Sieur de Monts Spring. The highest elevation at which it has been found was under a damp log on Flying Squadron Mountain.

Desmognathus fuscus fuscus (Rafinesque).—Many dug from a spring at Town Hill. Occurs under rocks in various streams.

Plethodon cinereus (Green).—Sometimes found in moist, rotten logs, or under rocks near water.

Eurycea bislineata bislineata (Green).—Occasionally turned up under rocks at stream-sides. There are records from Bear Brook, Hadlock Brook, Hull's Cove Brook and Sargent Mountain. It has not been recorded from above 500 feet elevation.

Bufo americanus Holbrook.—Found from sea level to 1500 feet elevation. Common.

Rana pipiens Schreber.—Occurs in streams, swamps, and damp meadows. Common.

Rana palustris Le Conte.—In streams and meadows, and at the south end of the Tarn.

Rana sylvatica Le Conte.—In damp woods near Sieur de Monts Spring, the Tarn, Upper Mill Pond and along Norway Drive.

Rana clamitans Latreille.—In streams and lakes, springs and swamps. It occurs from near sea level to 1070 feet elevation, at which altitude it was found in a pool on the summit of Bernard Peak. Common.

Rana catesbeiana Shaw.—In several of the larger bodies of water, such as Seal Cove Pond, Eagle Lake and the Tarn.

Hyla crucifer Wied.—Has been seen at Bar Harbor, Clark's Cove, and in the woods south of the Tarn.

Hyla versicolor versicolor (Le Conte).—There are two unverified records from the woods near the Tarn. It has not been seen by the author.

Diadophis punctatus edwardsii (Merrem).—Occasionally found under rocks or logs in woods. Reaching 720 feet elevation, on Huguenot Head.

Opheodrys vernalis (Harlan).—Found in logs or at large in meadows, from near sea level to a locality on Champlain Mountain at an altitude of 1050 feet. Common.

Lampropeltis triangulum triangulum (Lacépède).—Many killed on the roads by automobiles. No records from above 200 feet elevation. Sometimes found at the very edge of salt water. Common.

Storeria occipito-maculata (Storer).—Occurs in damp places, under stones and loose bark, from near sea level to a locality on Cadillac Mountain above 1500 feet elevation.

Thamnophis sirtalis sirtalis (Linnaeus).—The most common and widespread snake of the island, from near sea level to over 1500 feet elevation, as on Cadillac, Sargent, Flying Squadron and South Bubble Mountains. Many are killed by automobiles.

Chelydra serpentina (Linnaeus).—The most abundant turtle of the island. Specimens from a garden at Salsbury Cove, on the Kebo Mountain golf course, and in the Muck Swamp.

Sternotherus odoratus (Latreille).—Reported from the Muck Swamp, Bubble Pond and Echo Lake. No examples have been seen by the author.—RICHARD H. MANVILLE, *University of Michigan, Ann Arbor, Michigan.*

A RED EFT FROM FLORIDA.—Professor A. H. Wright has kindly loaned me his copy of the abstract of Mr. Harry Jopson's doctoral thesis, on the eastern species of *Triturus*. I was particularly struck with Jopson's remark in speaking of *Triturus viridescens symmetrica* (Harlan): "It seems likely that xerophytic conditions in the southern part of the range of the subspecies prevent it from passing through a terrestrial immature stage." That this is not invariably true is proved by a find made this winter.

In company with Mr. and Mrs. W. E. Schevill of the staff of the Museum of Comparative Zoology, I spent some time excavating a fossil deposit a few miles north of Bell in Gilchrist County, Florida. The locality was in dry, sandy scrub. There was a "sink," perhaps half an acre in extent, which evidently at times held water but which had obviously been bone dry for some time. A short distance beneath the surface, however, the ground was moist and at one level we encountered a band of extremely wet sticky clay, about the consistency of well moistened modeling clay. In this, almost two feet below the surface, we found a tiny red eft tightly curled in a small cavity in the moist clay. The little animal was bright red with the longitudinal light stripe particularly conspicuous on the midbody area.—THOMAS BARBOUR, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

HABITS OF *RHADINAEA FLAVILATA*.—The yellow lipped snake, heretofore considered rare and its habits little known, I found to be very common in a certain limited area near Burbank, Florida, where the species can be collected at any time. On March 28, 1937, I collected twenty-one specimens, and in about thirty days a farmer collected eighty from this same area.

These snakes are usually found under logs and bark in the open flat woods of pine and oak. Specimens kept in captivity are nocturnal, hiding during the day and crawling out at night. They have a somewhat prehensile tail, which breaks off readily; many of the specimens collected were stub-tailed. They make shallow burrows in the sand, tunneling in all directions. Oak toads, *Bufo quercicus*, and cricket frogs, *Acris gryllus*, are readily eaten.

A large female laid three eggs on August 19, 1937, measuring 23 mm. in length and 8 mm. in diameter. The eggs hatched in September but the babies were several days old when discovered. Their average total length was 167 mm., length of tail 41 mm.

For sixty adults the length averaged 325 mm.; the largest specimen measured 402 mm.; another specimen from Burbank, Florida, collected October 6, 1937, measured 338 mm., length of tail 102 mm., and weighed 9 grams.

The range of this species is not well known in Florida. We have specimens from Alachua, Marion, Sarasota, Glades, and Palm Beach counties.—E. ROSS ALLEN, *Reptile Institute, Silver Springs, Florida.*

GROWTH OF AN INDIVIDUAL BOX TURTLE.—Dr. Nichols' interesting data on the growth of the box turtle in COPEIA (1939: 14) have tempted me to submit a note on a female box turtle which I have had under continuous observation since October 30, 1930. This turtle was dug up on the above mentioned date from a "marked" nest (eggs laid June 28, 1930, at Pocasset, Cape Cod). It had only partially emerged from the shell. At that time the carapace length (in a straight line) was 29 mm. Each subsequent year it has gone into hibernation during October and begun feeding in May. During the winter periods there has been no growth, but during the summers a very irregular rate of growth is shown, probably due in part to the waxing and waning of my enthusiasm in feeding.

For the first six years it refused all vegetable food, taking only sow bugs, flies, worms, meat and fish. During 1937 it first took melon and berries, but only if animal food was not available, and this preference has continued. At present (March, 1939) the carapace length is 101 mm. The shields on the carapace show eight growth rings which vary in size with no orderly sequence. This turtle is undoubtedly behind normal growth rate, but is of interest as an individual under continuous observation from birth for nearly nine years.—HAROLD L. BABCOCK, *Boston Society of Natural History, Boston, Massachusetts.*

REVIEWS AND COMMENTS

A CHECK LIST OF NORTH AMERICAN AMPHIBIANS AND REPTILES. Fourth edition. By Leonhard Stejneger and Thomas Barbour. Harvard University Press, Cambridge, 1939: xvi + 207 pp. $4.00.—Now in its fourth edition, the *Check List of North American Amphibians and Reptiles* is almost as much an institution as the "Check-List" of the American Ornithologists Union. The authors deserve the renewed thanks of herpetologists generally for their combined labor of love in the present edition.

The first edition of the *Check List*, published in 1917, listed 504 species and subspecies. This has increased to 687 in the present list, and much of this increase can be traced to the stimulus of the successive editions. The chaos which characterized the nomenclature of North American amphibians and reptiles before 1917 is scarcely imaginable to students who have begun their work since that time.

It is gratifying to find recent work so well considered in the new edition. Notable changes since the last edition have been introduced due to the work of Viosca and Bishop on salamanders; of Smith, Fitch, and Taylor on lizards; of Klauber, Gloyd, Clay, Blanchard, and Stickel on snakes; and of Stejneger and Carr on turtles; and, of course, numerous other authors. While certain choices on the part of the authors of the *Check List* are of necessity arbitrary, it is doubtful whether a check-list committee could reach a more satisfactory agreement in the present state of our knowledge of various groups.

It is the nature of such a list to invite additions and corrections, but it is not the function of the present review to enter upon such factual criticism. Changes found to be necessary will, it is hoped, be submitted to the *Herpetological Notes* section of COPEIA. Except for papers dealing specifically with proposed changes in nomenclature or classification, or with reference to authority for a deviation, it will be the editorial policy of COPEIA to follow the present edition of the *Check List*.

A more liberal use of foot-notes to explain combinations omitted from the new list would add to the usefulness of the work. It is gratifying that the paper on which the present edition is printed takes both ink and pencil well. For the rest, we commend the work to our herpetological colleagues with the hope that it may stimulate further work on our fauna, and especially that it may promote the summarizing works which are so much needed for every group except the snakes.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

WHAT SNAKE IS THAT? A FIELD GUIDE TO THE SNAKES OF THE UNITED STATES EAST OF THE ROCKY MOUNTAINS. By Roger Conant and William Bridges. D. Appleton-Century Company, New York, 1939: I–VIII, 1–163, 35 pls., 1 map. $2.00.—A simple introduction to the snakes of eastern North America, illustrated with diagrammatic drawings of the color patterns and occasionally of other characters. The scheme of the diagrams varies, and there is no explanation of the fact that most of them represent flattened out skins. The most cursory glance suffices to prove that no satisfactory drawing of a snake can omit the scales, and that their mere indication (cf. fig. 1, the "glass lizard") will not do. The authors' statement that these are the finest North American snake drawings in existence is either a libel or a sad reflection on the state of herpetological drawings in our country.

The keys for identification have been greatly simplified by the introduction of a geographic restriction. The nomenclature is meticulously up to date, and the text is noteworthy also for freedom from error. The reviewer objects strongly to certain matters of form, such as the capitalization of common names of animals, which is reduced to absurdity in the capital M in man. The heading "Similarity" for a paragraph attached to a few of the descriptions is unfortunately chosen.

There is a simple and adequate section on the treatment of snake bite.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

A LABORATORY INTRODUCTION TO ANIMAL ECOLOGY AND TAXONOMY. A laboratory guide with keys prepared with particular reference to fresh-water and terrestrial habitats of the deciduous forest region in North America. By Orlando Park, W. C. Allee, and V. E. Shelford. University of Chicago Press, Chicago, 1939: I–X, 1–272, 17 pls. $2.—The importance of an introductory course in field zoology is widely recognized in American universities, and with the growth in numbers of beginning classes, formulation of such courses has become more and more essential. The present laboratory course is developed on the basis of such field courses, supplementing field collecting and observation with the more orderly and exact observations possible in the laboratory. The writer feels that the laboratory exercises might profitably be multiplied with the idea of affording alternatives for students with special interests. Herpetologists will be gratified at the inclusion of the exercises dealing with toads and turtles.

The bibliography offers an extensive reading and reference list. The fact that even so large a list must still completely lack systematic suveys of numerous groups is due directly to the decline in interest in taxonomic studies in universities, and to the fact that museums, which remain the strongholds of taxonomic research, are so seriously understaffed. The reviewer would suggest sending students (for further browsing in the vertebrate literature) directly to some of the more essential modern journals, like COPEIA, the *Auk*, and the *Journal of Mammalogy*, not to mention *Ecology*.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

TURTLES OF THE UNITED STATES AND CANADA. By Clifford H. Pope. Alfred A. Knopf, Inc., New York, 1939: i–xviii, 1–343, bibliography, index i–v, 99 halftone photographs. $3.75.—Long neglected have been the turtles but at last they have found their place in the sun and not just on a moss-covered log. For Clifford H. Pope has tracked the age old reptiles through the literature of herpetology and emerged with the *Turtles of the United States* alive, alert, active. No, turtles do not fly, but Mr. Pope hastens to explain that they do almost everyhing else and he proves his point in this—the only book on all our turtles in print.

The universal question implied in Ogden Nash's "the turtle lives twixt plated decks that practically conceal its sex—how very clever of the turtle in such a fix to be so fertile" is ably answered in all instances where information was available and the reviewer is happy to report that the language is clear and precise. In addition the first chapter also answers many general queries regarding the natural history of the turtle. Then in the style evolved in *Snakes Alive* the author presents keys that really aid in identifying adult turtles, offers a list of turtles with common and scientific names, includes what he considers the most important monographs and papers on the subject, adds a useful index.

Interesting and important facts and figures concerning each of the sixty odd species of native chelonians are given under topic headings: identification, size, young, sexes, eggs, longevity, growth, distribution, habitat, habits, reproduction, food and feeding, enemies, propagation, market value, protection and conservation.

Ninety-nine photographs, the great majority from the camera of Mark Mooney, Jr., photographer of the Zoological Society of Philadelphia, depict most of the important native species and subspecies. Critically focused, interestingly lighted illustrations lend the volume a brilliant quality and catch the spirit of the creatures described with something of the same sensitive fidelity encountered in the celebrated camera studies made in the New York Zoological Park by its former photographer Elwin R. Sanborn and its reptile curator Dr. Ditmars. Portrait close-ups like that of the Florida red-bellied turtle shown on plate 75 are especially effective but it is to be regretted that the sea turtles shown were taken on grass and not on sand or in water.

Praiseworthy were the efforts of the author and his wife, Sarah H. Pope, in card-indexing, cataloguing and organizing materials scattered through more than eight hundred monographs and papers on North American turtles alone. The world literature on the subject, known to the reviewer to contain at least five thousand items, was also consulted in part and is reflected in their work which will be a standard source for many years to come. Naturalists, nature-lovers and others will want to possess this clearly printed octavo-sized handbook and librarians can no longer complain to inquisitive

readers of all ages "there is no book on turtles of the whole country, why doesn't someone write one?"—RALPH DE SOLA, *Zoological Editor, Federal Writers' Project, New York City.*

THE ACANTHODIAN FISHES. By D. M. S. Watson. Philos. Trans. Royal Soc. London, ser. B, no. 549, vol. 228, 1937: 49-146, 25 text-figures, 9 plates.—On May 11, 1934, Prof. Watson spoke before the American Society of Ichthyologists and Herpetologists in New York. His address (to the reviewer the most interesting one on the program) concerned those strange little Paleozoic fossils usually referred to as the "acanthodian sharks," pictured in all texts on fossil vertebrates but really very incompletely known. Prof. Watson's lucid descriptions and chalk sketches on the blackboard made his listeners realize what remarkable creatures these little fishes actually were. His remarks on that occasion are now abundantly illustrated by the memoir before us.

The acanthodians are the oldest and most primitive jawed vertebrates known, and they are certainly not sharks. Most important of Prof. Watson's findings is that these fishes had a full-sized, functional gill-slit *between the mandibular and hyoid arches,* a slit of which the elasmobranch and crossopterygian spiracles seem to be remnants. The acanthodians show, within the group, the development of the mandibular operculum from a partial to a practically complete gill-cover. The group possessed both dermal and perichondrial bone, and some genera even had ossified vertebrae. The neural cranium is remarkably unlike that of later groups, and differs particularly from that of the elasmobranchs in its strange ossification, long occipital region, and truncated preorbital section.

In an exceedingly able comparison with other ancient fishes, Prof. Watson shows that the acanthodians cannot be considered as ancestral to the sharks, chimaeroids, or any recent fishes. He gives good evidence that they are, instead, related to the Arthrodira, *Macropetalichthys,* and (probably) *Gemündina,* and may be placed with them in a new "grade" (superclass), the Aphetohyoidea, distinguished by the possession of a complete prehyoid gill-slit, and from some unknown members of which the elasmobranchs and teleostomes must have arisen.

The reviewer dislikes to quibble about trifles in so splendid a paper but he can see no justification for Prof. Watson's alteration of the names Arthrodira and *Dinichthys.*[1] —GEORGE S. MYERS, *Stanford University, California.*

CHANGES IN THE SALMON SKULL. By V. Tchernavin. Trans. Zool. Soc. London, vol. 24, part 2, 1938: 103-184, 5 plates.—The physiological make-up of the salmonid fishes, and its expression in their physical changes and habits during life and at breeding time, is of interest not only as abstract science but also as a practical fisheries problem of large economic interest. The paper now reviewed is an important contribution to knowledge of one phase of this subject, the normal growth-changes and breeding modifications of the skull of *Salmo salar,* as compared to those of *Oncorhynchus.* The differential development of various parts, particularly the rostral region of the males, is given particular attention, based on a carefully determined method of measuring differential growth in fish skulls in a constant state of change. Summary in this place of the results is difficult, due to their abundance and to the fact that the author has had to attempt the segregation of the effects of distinct physiological processes on a morphological basis. Of interest to systematists is the conclusion that the genera *Salmo* and *Oncorhynchus,* as currently recognized, are definable on cranial characters, as opposed to Regan's suggestion that some West American trouts would have to be placed in *Oncorhynchus* if the genus were recognized. In conclusion, it is difficult to understand why Tchernavin so curtly dismisses Davidson's brief account of breeding changes in *Oncorhynchus,* which anticipated (in English, at least) a few of his own general findings, even though Davidson's paper does contain certain anatomical inaccuracies.—GEORGE S. MYERS, *Stanford University, California.*

SOCIAL LIFE OF ANIMALS. By W. C. Allee. W. W. Norton & Co., New York, 1938: 287 pp., 49 figs., 5 pl. $3.00.—During the past 25 years or so there has developed a large body of knowledge about the phenomena of animal society. Though this branch

[1] The Rules of Nomenclature also unfortunately require that the name *Acanthodes* be replaced by the older *Acanthoëssus.*

of Ecology, Physiology, Psychology, or whatever you will call it, is still more or less in the descriptive stage, there is beginning to grow out of the mass of observations collected a pattern from which some useful principles can be derived. Dr. Allee's book deescribes briefly and in untechnical language some of the more interesting of these observations and principles. It is an important book because it brings together and summarizes literature that has been scattered in a variety of journals and books and it provides a ready-made working bibliography.

Social behavior is a subject which students of wild life management cannot, of course, avoid. Fishery workers, for example, are very deeply concerned with the effects of over- or under-crowding on growth, mortality and survival. In this connection, Dr. Allee's experiments on gold-fish are particularly interesting and suggestive.—L. A. WALFORD, *Jordan Hall, Stanford University, California.*

CONSERVATION IN THE UNITED STATES. By A. F. Gustafson and Others. Comstock Publishing Co., Ithaca, New York, 1939: xi + 431, 232 figs. $3.00.—"It is the aim of this book," the authors say, "to present the principles of conservation to the readers so that he may gain an understanding of tomorrow's problems and be in a position to deal effectively with them." At the same time the book has been written with an eye to the need of a text for college courses in Wild Life Management and Conservation. The presentation is in four parts. Part one deals with soil and water resources; part two with forests, parks and grazing lands; part three with wild life, part four with mineral resources. The interrelation of all these subjects is well indicated throughout. The book is particularly well illustrated with good photographs and diagrams, all of which are interestingly captioned. The pictures themselves tell a dramatic story of man's waste of community wealth, and of his almost-too-late efforts to restore it. It is a pleasure to find fishery conservation given the attention of an entire chapter of 33 pages, a good one too, and not just relegated to a brief paragraph labeled "miscellaneous." There is a brief bibliography which would have been better had it listed some of the important European literature.—L. A. WALFORD, *Jordan Hall, Stanford University, California.*

ANIMAL LIFE IN FRESH WATER.—A GUIDE TO FRESH-WATER VERTEBRATES. By Helen Mellanby. Chemical Publishing Co., New York, 1938: viii + 287, 211 figs. $3.50.—Professor L. E. S. Eastham says in the forward to this book "It is unfortunate, in view of the fact that the majority of students of Zoology enter the teaching profession, that the increasing load of instruction in morphology, physiology, cytology, genetics, evolution and the like frequently makes a personal study of animal life in relation to environment almost impossible." It is to help such sadly trained people make up for their lack that the author has prepared this book. It is a handbook to British fresh-water invertebrates, describing all groups down to families, or if the groups be not too large, to genera or even species. Descriptions are models of simplicity, being generally based on characters that are obvious and visible to the naked eye, and they are accompanied often by excellent line drawings, and wherever information is available, by copious life history notes. References to pertinent literature are given at the end of each chapter for those who wish to look for further information.—L. A. WALFORD, *Jordan Hall, Stanford University, California.*

DICTIONARY OF SCIENTIFIC TERMS AS USED IN THE VARIOUS SCIENCES. By C. M. Beadnell. Chemical Publishing Co., New York, 1939: x+235. $3.00.—This book is intended as a reference to technical words found in scientific literature. About 3500 words are included, being those most commonly met in all the fields of science, particularly biology. The work is based, the author says, "on notations taken from recently published scientific books and from articles in scientific periodicals by recognized authorities." Those terms have been selected for definition which are most likely to be met by students and laymen interested in scientific literature. Numerous cross references serve as a useful guide to synonyms, antonyms and to related words. This book is not a dictionary in the true sense, i.e., derivatives are not given and some definitions are more discursive than those provided by most dictionaries. It is a convenient little desk book, and no doubt would enjoy a fair popularity among the audience it addresses were its price about a third what it is.—L. A. WALFORD, *Stanford University, California.*

PREHISTORIC LIFE. By Percy E. Raymond. Harvard University Press, Cambridge, Mass., 1939; i-ix, 1-312, 156 figs. $5.00.—The author states that "It is the purpose of this book to trace the history of life from the time of its first appearance on the earth to the present." It would have been more accurate to say, "history of animal life," for plant life, which surely ought to be an important part of the story, is relegated to a brief 8-page chapter, "The Importance of Plants." For the zoological paleontologist, however, the book is a good, well organized account of the development and flowering of the main groups of animals. Of especial interest is the inclusion of the results of recent research. The account of the history of early fishes is excellent. It is unfortunate that the story is not carried through the teleost fishes, which are almost entirely ignored.

The figures are many and well-chosen, but an unnecessarily large number are too small to be of much use. With occasional re-arrangement (and without unduly disturbing the layout of the text) nearly a third of them could have been enlarged to from a third to almost double their present size, to the vast improvement of both the value and the appearance of the book.

With all due respect to the author's erudition and his rather able handling of a vast subject, we are led to wonder why books like the present one are written and published. It is not a "popular" book in the way that Barbour's "Reptiles and Amphibians" is. One would have to possess a good knowledge of vertebrate and invertebrate comparative anatomy to understand many of the chapters. Few lay readers possess such information. A working zoologist, wishing to gain a knowledge of paleontology, or to look up specific subjects, would find the book diffuse, as well as annoying by reason of the entire lack of bibliographic references. As a text book for beginning students in paleontology, it requires larger knowledge of comparative anatomy than can reasonably be expected, and is much more heavily weighted on the vertebrate side, than the present constitution of the professional paleontological field warrants. There are, moreover, already several texts that cover the fossil vertebrates rather well.—REVIEW COMMITTEE.

NEW BOOKS RECEIVED

A KEY TO THE SNAKES OF THE UNITED STATES, CANADA, AND LOWER CALIFORNIA. By Frank N. Blanchard. Reprinted from Papers of the Michigan Academy of Science, Arts, and Letters, 4, Part 2, 1925. University of Michigan Press, 1939: xi + 65. 80c.

AN ANNOTATED BIBLIOGRAPHY OF THE ZOOLOGY OF TENNESSEE. By Charles S. Shoup. The Midland Naturalist, 21 (3), 1939: 583–635. May be purchased from Vanderbilt University Bookstore, Nashville, Tennessee. 50c. Approximately 1000 titles are listed which contain lists or descriptions of species from Tennessee and the Tennessee Valley region. An index of 216 localities from which collections have been made is included.

KEY TO THE FISHES AND FISH-LIKE ANIMALS OF JAPAN. By Yaichiro Okada and Kiyomatsu Malsubara. The Sanseido Co., Ltd., Tokyo and Osaka, 1938: 584 pp., 113 pls.—A Check List with keys and scientific names in Japanese, scientific names also in English. Separate Japanese and English indexes.

A CATALOGUE OF VERTEBRATES OF JAPAN. By Yaichiro Okada. Maruzen Co., Ltd., Tokyo, 1938: 412 pp. $3.00.—Scientific names and ranges in English. Separate English and Japanese indexes.

SELECTED LIST OF BIBLIOGRAPHIES OF THE POLAR REGIONS, PART I. Published under sponsorship of the Explorers Club and compiled and edited by a staff supplied by the United States Works Progress Administration for the city of New York, 1938: 41 pp., mimeographed, 450 entries.—Compiled from books and serial publications of the past 30 years.

ANGLING IN AMERICA; ITS EARLY HISTORY AND LITERATURE. By Charles Eliot Goodspeed. Houghton Mifflin Co., Boston, 1939: xiv + 365, several plates. $15.00.

BIO-ECOLOGY. By Frederic E. Clements and Victor E. Shelford. John Wiley & Sons, New York, 1939: vi + 394, 84 figs. $4.50.

PALAEOZOIC FISHES. By J. A. Moy-Thomas. Chemical Publishing Co., New York, 1939: viii + 132, 32 figs. $2.00.

EDITORIAL NOTES AND NEWS

Meeting of the Western Division THE eleventh annual meeting of the Western Division of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS was held at Stanford University, June 28–29, 1939. On June 28 the following papers were presented:

1. Problems in the Classification of Some California Freshwater Fishes—Leo Shapovalov.
2. Preliminary Studies of the Denning of the Desert Tortoise, Gopherus agassizii—A. M. Woodbury and Ross Hardy.
3. Darwinism in Contemporary Social Evolution—Paul D. R. Rüthling.
4. Specimen Species and Real Species—G. F. Ferris.
5. The Species of Triturus in British Columbia—Gertrude Smith Watney.
6. Observations on the Philippine Sea Snakes—A. W. Herre.
7. Notes on Metabolic Levels of Dipsosaurus dorsalis and Sceloporus occidentalis over a Period of Five Months under Temperature Control—F. M. Baldwin and P. W. Eberle.
8. Some Notes on the Physiology of Warm-Spring Fishes—F. B. Sumner.
9. Reproductive Cycles in the Sagebrush Lizard, Sceloporus g. graciosus—A. M. Woodbury and Marian Woodbury.
10. Observations on the Rate of Development of the Pacific Dogfish, Squalus suckleyi—L. E. Griffin.
11. Remarks on the Systematics of California Skinks—T. L. Rodgers and H. S. Fitch.
12. The Herpetological Collections of the Stanford Natural History Museum—George S. Myers.

The Business Meeting was held at 1:42 P.M., with PRESIDENT FRANCIS B. SUMNER presiding. The officers elected for the ensuing year were: *President,* DR. WILBERT MCLEOD CHAPMAN, Seattle, Washington; *Vice-President,* DR. TRACY I. STORER, Davis, California; *Secretary-Treasurer,* MISS MARGARET STOREY, Stanford University, California. The following resolution was presented and adopted:

The American Society of Ichthyologists and Herpetologists, Western Division, records with profound regret the passing of one of its most distinguished members, Professor Joseph Grinnell of the University of California. While Grinnell's zoological studies have related to groups other than those falling within the scope of this Society, his ecological and distributional contributions have had bearings which far transcend the fields of ornithology and mammalogy. Grinnell was, furthermore, a stimulating teacher, a highly effective worker for the conservation of wild life, and the valued friend of a large number of our members. His untimely passing is a serious loss to science and to his many friends.

On June 29 the DIVISION met in joint session with the WESTERN SOCIETY OF NATURALISTS, F. B. SUMNER presiding. The program consisted of a symposium on dams and the problem of migratory fishes. The following papers were read and discussed:

1. Fishery Problems Raised by the Development of Water Resources—W. H. Rich.
2. The Passage of Fish at Bonneville Dam—H. B. Holmes.
3. Fish Problems Connected with the Grand Coulee Dam—W. M. Chapman.
4. The Sacremento River Salmon-Salvage Problem—H. A. Hanson.
5. Summary of the Present Status of Dams versus Migratory Fishes on the Pacific Coast, with Especial Reference to Problems in California—A. C. Taft.

The accompanying resolution, presented by GEORGE S. MYERS, was unanimously adopted:

The Western Division of the American Society of Ichthyologists and Herpetologists and the Western Society of Naturalists, being assembled at Stanford University, California, at this annual meeting and having considered in considerable detail the effects of dam construction in west coast waters and their incident and usually harmful effect on migratory fishes such as salmon and steelhead trout, hereby offer the following resolution to be presented to the various federal and state agencies, National Resources Committee, Western State Planning Boards, Water Resources Committees, and other bodies concerned with water planning programs:

Whereas, construction of the Bonneville and Grand Coulee Dams on the Columbia River in Oregon and Washington, the Shasta Dam on the upper Sacramento River in California, and other such federal and state projects has, and will continue to, greatly jeopardize the continued productivity of salmon and steelhead trout to the people of west coast states, and

Whereas, actual construction work on each of these dams has, almost without exception, been begun without sufficient advance consideration of the effects of the proposed structures on salmon and trout, therefore

Be It Resolved; that fisheries resources be given consideration equivalent to that given all other water uses by federal and state planning or construction agencies and that before starting construction of any dam or other type of structure proposed in any basin containing salmon or steelhead trout, surveys of the fisheries resources be made by qualified experts, to parallel engineering surveys, over a minimum period of five years, or sufficient to cover the life cycles of all economically important fishes concerned.

The meeting ended with an Open House at the Natural History Museum.—MARGARET STOREY, *Secretary.*

News Notes

ARTHUR LOVERIDGE of the Museum of Comparative Zoology, who has been spending the last nine months in Central and East Africa as a Fellow of the John Simon Guggenheim Memorial Foundation, is homeward bound by the S. S. Dunbar Castle and expects to reach Cambridge early in September.

He writes us that he has a mass of data on the herpetofauna of the forest "islands," and quite a number of new forms. About 650 snakes were collected, referable to 71 species, i.e. exactly half the total of forms recognized as occurring in the British East African territories. About the same number of amphibian species and some fifty forms of lizards were collected.

Two new methods of collecting were adopted; the first unromantic and unpleasant, the ears assailed by an unholy din, the nostrils by crude oil in a Diesel engine, and by clouds of dust, while walking slowly to and fro under a tropical sun on the coastal plain. Recently a planter named Hartmann introduced several American ten-ton tractors for clearing bush and ploughing the ground on a grand scale. Learning that two of them were engaged in "spreading" piles of rotting sisal, roots, bushes and trees which they had piled in quarter-mile-long lines some months before, Loveridge moved his camp to the patch of forest beside which they were working. By following a tractor to and fro for two and a half days of six hours each he captured a number of snakes, mostly burrowing forms, referable to 12 species and providing some unexpected, distributional records.

The other method, first adopted in despair of the dominant vegetation on Mount Ruwenzori, was to employ a couple of men from 4 P.M. till sunset (6 P.M.) to systematically cut the ten-foot elephant grass, sedge, and bush in a swamp to which elephants had made a path in their quest of wild bananas.

This resulted in the capture of *Dipsadoboa unicolor,* new to the Ugandan herpetofauna, some beautiful topotypes of the bamboo viper, *Atheris woosnami,* and amphibia whose presence was quite unsuspected though he had been camping in the vicinity for a fortnight. While Loveridge and two natives were engaged in frog-hunting in elephant footprints in this swamp, a chimpanzee climbed a lone tree on a knoll less than two hundred yards away and watched the proceedings intently. Having finally reached his own conclusions, he slowly clambered down and departed!

THE SIXTH PACIFIC SCIENCE CONGRESS of the Pacific Science Association met at Berkeley, Stanford University and San Francisco from July 24 to August 12, 1939. Eighteen sessions were held on various phases of Oceanography and Marine Biology, of which seven were on subjects related to fishery biology. The papers presented will be published in the Proceedings of the Congress.

DR. G. KINGSLEY NOBLE, of the American Museum, has been appointed visiting professor of biology in the Graduate School of New York University.

Panama collectors during the summer included DR. and MRS. E. R. DUNN, Haverford College, and JOSEPH R. SLEVIN, California Academy of Sciences.

DR. GORDON ALEXANDER has been appointed head of the Department of Biology, University of Colorado.

EDITH R. FORCE will be an exchange teacher in Liverpool, England, during the coming year.

DR. JEAN PIATT has been granted a National Research Fellowship. He leaves for Holland in September, where he will study with Prof. J. Boeke, Institute of Embryology, University of Utrecht, for a year.

DR. CARL L. HUBBS was appointed by the Honorable Harold Ickes, Secretary of the Interior, as special investigator of the Department of the Interior, to tour Alaska this summer and report upon all phases of the Alaska Fisheries with a view toward the improvement of this division of the Bureau of Fisheries subsequent to its transfer from the Department of Commerce to the Department of the Interior on July 1.

DR. DEOGRACIAS V. VILLADOLID, of the Department of Fisheries of the Philippine Islands, is visiting the fishery centers of the United States and Europe subsequent to his attendance as a delegate to the Pacific Science Congress.

STUART SPRINGER, of the Bass Biological Laboratory, Englewood, Florida, has been touring the country during the past summer studying sharks in various museums.

THE DIVISION OF FISHERIES of the Bureau of Science, Manila, Philippine Islands, has been removed from the Bureau and has been made an autonomous department.

DR. F. P. KOUMANS, of the Leiden Museum, is now back at the Museum after a trip around the world studying types of gobies and collecting a large series of specimens in the United States.

Biological Photographic Association

THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION was founded nine years ago because of the growing need for expert illustrative material for scientific research and teaching. Its aims are scientific. The Journal is published quarterly, constituting a volume of about 250 pages. Membership privileges include an authoritative question and answer service, the right to borrow loan albums and exhibits of scientific prints for study and display, and subscription to the Journal. The ninth annual convention will be held September 14–16, at the Mellon Institute for Industrial Research, Pittsburgh, Pennsylvania. The program will include discussions of interest to scientific photographers, a display of up-to-date equipment, and on exhibit will be the work of many of the leading biological photographers. Further information about the Association and the convention may be obtained by writing the Secretary of the Biological Photographic Association, University Office, Magee Hospital, Pittsburgh, Pennsylvania.

News of Local Herpetological Organizations

THE LONG BEACH CHAPTER of the JUNIOR HERPETOLOGICAL SOCIETY OF AMERICA, organized in 1932, is engaged in an ecological survey of the desert reptiles of southern California, following the techniques developed by DR. COWLES. They are also making an extensive study of *Xantusia riversiana*, and are co-operating with MRS. GRACE OLIVE WILEY in establishing a permanent educational exhibit at Long Beach.

The TEXAS HERPETOLOGICAL SOCIETY was organized on November 18, 1938, during the meeting of the Texas Academy of Science. The first regular field meet was held April 15-16, 1939, at San Marcos, with a registration of twenty-eight. Field trips were made in the vicinity, resulting in the capture of specimens of *Eleutherodactylus latrans* and *Syrrhophus marnockii*. Plans were made to afford protection to the rare salamander *Typhlomolge rathbuni*, and for a herpetological calendar to be compiled from the work and records of the members. Officers are D. C. S. SMITH, president, and OTTYS SANDERS, secretary. Herpetologists visiting Texas are cordially invited to get in touch with the secretary, Box 4084, Dallas, Texas.

Recent Deaths

DR. JAMES PLAYFAIR MCMURRICH died in Toronto on February 9, 1939. Although Dr. McMurrich's major interest was in Anatomy, he was preeminent among Canadian biologists in the breadth of his interests and in the stimulus he was to others. He had a life-long interest in fish and in problems connected with fisheries. In the early eighties, he contributed two parts to a series of monographs on the Anatomy of the Catfish (*Ameiurus*) published in the *Transactions of the Canadian Institute* and through the intervening years published a long series of papers on other problems connected with fish and fisheries. He was a member of the Biological Board of Canada from 1912 to 1938 and Chairman from 1926 to 1934, which coincided with the most active period of the Board's development. Dr. McMurrich's teaching career started at the Ontario Agricultural College and included Johns Hopkins University, Haverford College, Clark University, Cincinnati University, University of Michigan and University of Toronto. In the latter institution he was Professor of Anatomy from 1907 to 1930. He was largely instrumental in the organization and development of the School of Graduate Studies, University of Toronto, and served as its first Dean. He took a prominent part in the activities of many scientific societies, and served as president of the American Association for the Advancement of Science, the American Association of Anatomists, American Society of Naturalists and Royal Society of Canada.

Word of the death on Jan. 8, 1939, of the eminent Brazilian Zoologist, DR. ALIPIO DE MIRANDA RIBEIRO, was received by his colleagues in the United States with profound regret. Dr. Miranda Ribeiro was born in Rio Preto, Minas Geraes, on February 21, 1874. He became interested in natural history at an early age and at 14 he had translated into Portuguese some of the works of Buffon, for his own use. His primary education was received at home, his father having been a teacher. While studying in medical school at Rio de Janeiro he began work at the National Museum there, and in 1894 was appointed preparator in that institution. In 1899 he was made secretary of the Museum and after various promotions he became, in 1929, Head Professor in the Department of Zoology, a post he held until his death. In 1908 he accompanied Colonel (later General) Rondon, the famous explorer, to Amazonas and Matto Grosso, as zoologist of the Telegraph Commission Survey. In 1910 he visited Europe and North America for study, and upon his return he organized an *Inspectoria da Pesca,* the first official fisheries department in Brazil.

Although Miranda Ribeiro's earliest work was with parasites, he is known chiefly for his contributions to the vertebrate zoology of Brazil. His monumental *Fauna Brasiliense-Peixes,* totalling nearly two thousand quarto pages, will doubtless long remain the most important and useful faunal work on South American fishes, even though left incomplete at his death. Many other ichthyological papers, especially on fresh-water fishes, continued to appear, the most important being those in the Telegraph Commission Reports. In 1920, Miranda Ribeiro began the publication of a series of papers on frogs, which culminated in 1926 in a quarto volume on Brazilian amphibians. Although herpetologists in general have not followed Miranda Ribeiro's generic arrangement, the work remains one of the most important contributions to South American batrachology. In later years Miranda Ribeiro was pressed by his official superiors to abandon his chosen field and to contribute more extensively to fields they considered more important. This resulted in a number of papers, more particularly on the parrots and cetaceans, but his last papers that reached us concern the fishes and amphibians of northeastern Brazil. He published in all some 140 papers, a considerable proportion of which were of considerable extent.

Miranda Ribeiro was undoubtedly the greatest ichthyologist that the continent of South America has produced, and his work was highly regarded by all foreigners who had occasion to work on Brazilian fishes. This and his contributions to other groups rank him as the most distinguished Brazilian vertebrate zoologist of his time, and his passing is deeply mourned. One of his three sons, Paulo de Miranda Ribeiro, has already begun work at the Museu Nacional in the desire to carry on his father's important ichthyological work.—GEORGE S. MYERS, *Stanford University, California.*

The death of JOSEPH GRINNELL on May 29, 1939, is an irreparable loss to Science in general as well as to Natural History in particular. Grinnell was born in Oklahoma, February 27, 1877. Following his undergraduate work at Throop Institute (now California Institute of Technology) and his graduate training at Stanford under Doctors Jordan and Gilbert, Dr. Grinnell organized and became the first Director of the Museum of Vertebrate Zoology at the University of California, now recognized as probably the most active and efficient regional museum devoted to the study of the vertebrates above fishes. Grinnell conceived the idea of an intensive survey of the higher vertebrates of the Pacific Coast of North America and carried through his work with a precision and thoroughness that has seldom been equaled. He was not interested alone in the precise definition of taxonomic forms, but also in exact ecological and zonal relationships of the species, and their habits in the field. His influence in the fields of Vertebrate Taxonomy and Ecology extended far beyond the boundaries of the region he took for his own, and to his interest is due, in large part, a great deal of the recent work that has been done in western Herpetology. Dr. Grinnell constantly refused to have the Museum of Vertebrate Zoology undertake work in Ichthyology, which he believed could be better done with less overlapping of effort by his Alma Mater, Stanford University. Nevertheless, he was deeply interested in the progress of work on western fishes and furthered it in many ways unknown even to most ichthyologists. His sudden death was a shock to his innumerable friends and colleagues.

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